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PUBLIC WORKS

NEW YORK
June 4th 1921

The site of the Gilboa Dam which will turn the flow of Schoharie from north to south through the world's longest tunnel. The contractor's plant is remarkably complete.

De Laval

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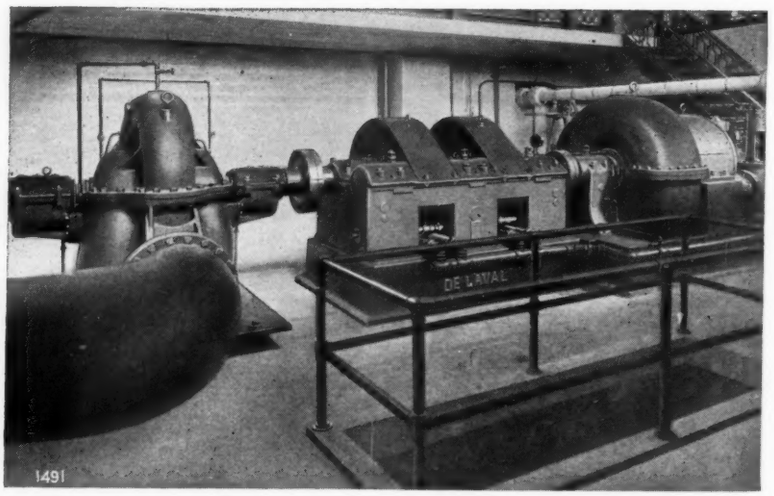

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STEAM TURBINE CO.

TRENTON, NEW JERSEY

Number 167

PUBLIC WORKS.

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World's Longest Tunnel for New York's Water Supply

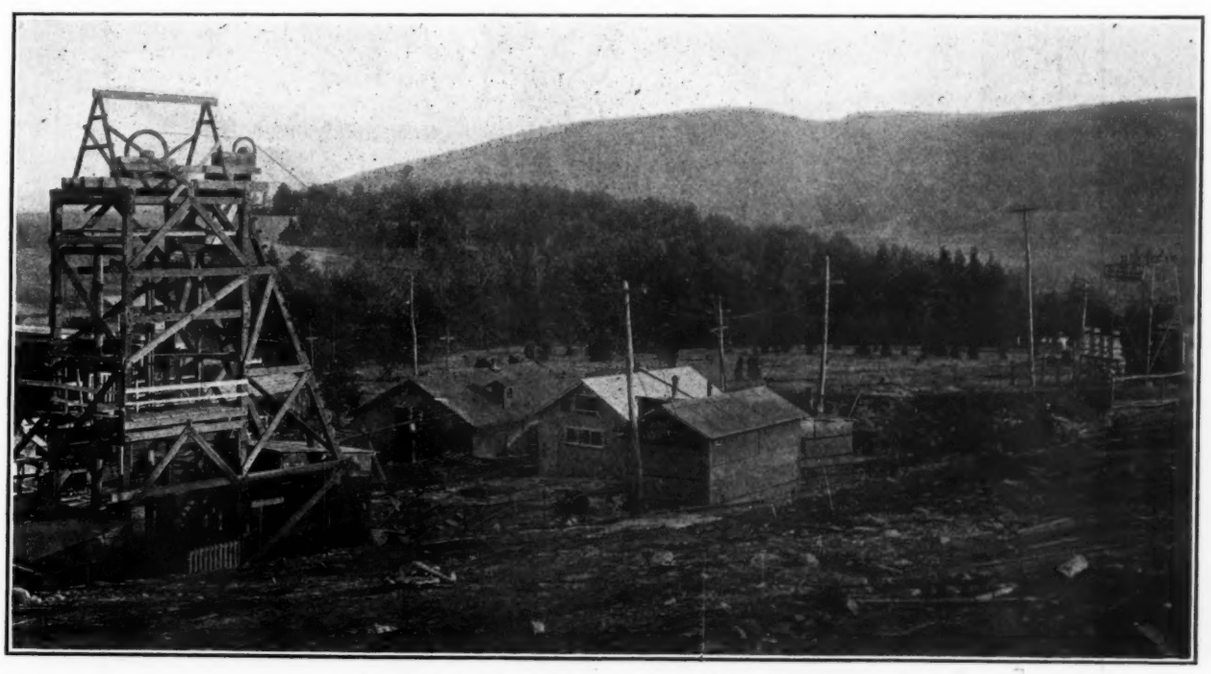
A tunnel more than eighteen miles long under the Catskill mountains, is being built by the largest city in the country to supply itself with the largest amount of the best water. The engineers in charge probably constitute the largest, oldest and finest organization of its kind.

The Board of Water Supply of New York City has begun construction on the longest tunnel so far built for any purpose whatever. This tunnel is also remarkable because of its purpose, which is to compel Schoharie creek, which now flows northward into the Mohawk river, to reverse its direction of flow and discharge its waters into the Ashokan reservoir, miles to the south of its source.

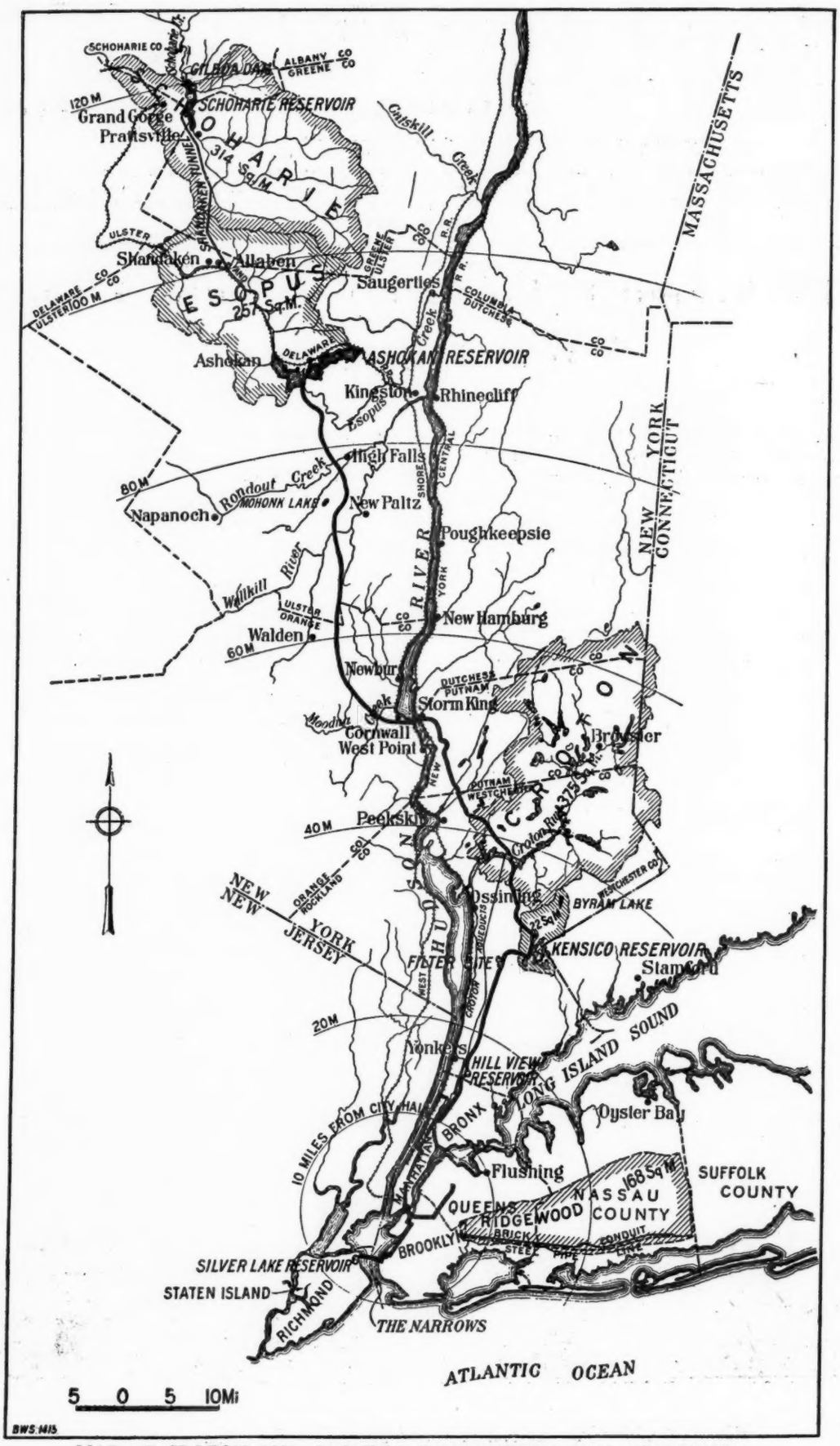
The Catskill mountains form a summit in the topography of eastern New York, from which streams flow to the south and east into the Hudson, to the north into the Mohawk and to the west into the Delaware river.

In selecting a watershed in the Catskills for New York's water supply which would at once provide abundant head and a safe and economical location for a reservoir, the Esopus creek was chosen as the first development, and the Ashokan dam was built on this creek, from which a supply is brought by gravity through the 92 miles of the Catskill aqueduct to the city's northern boundary. The Esopus flows south and east into the Hudson and the natural topography of the land therefore favored this scheme.

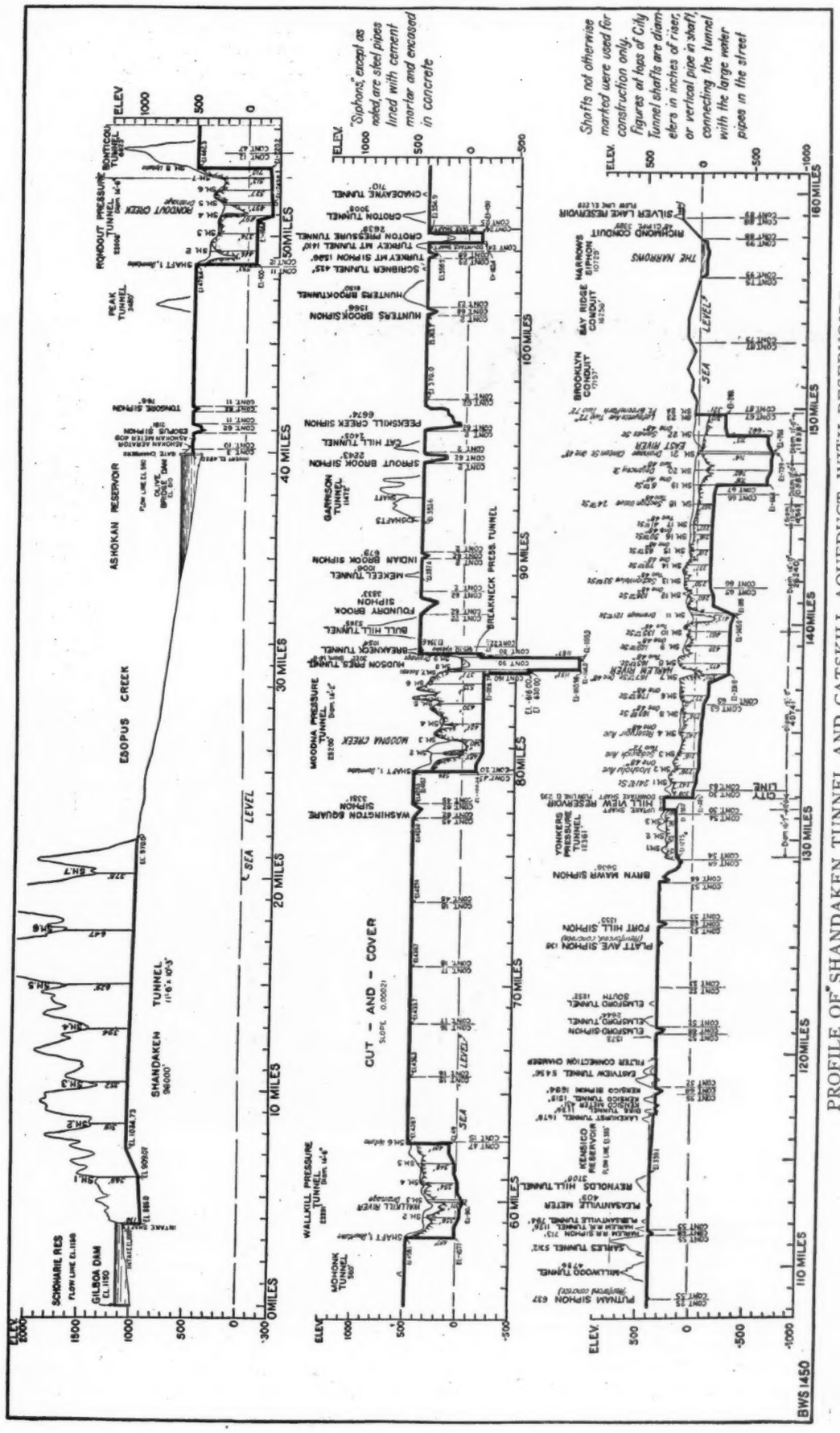
The supply from the Esopus, however, will be insufficient for many more years of the city's growth. In fact, the city for the past four years



VIEW OF SHAFT NO. 1, LOOKING NORTH
THE STRUCTURES FROM LEFT TO RIGHT ARE AS FOLLOWS: HEAD-FRAME OVER SHAFT; COMPRESSOR HOUSE; HOIST HOUSE; SWITCH HOUSE AND TRANSFORMERS AT THE EXTREME RIGHT



MAP OF CROTON AND CATSKILL WATERSHEDS AND AQUEDUCTS



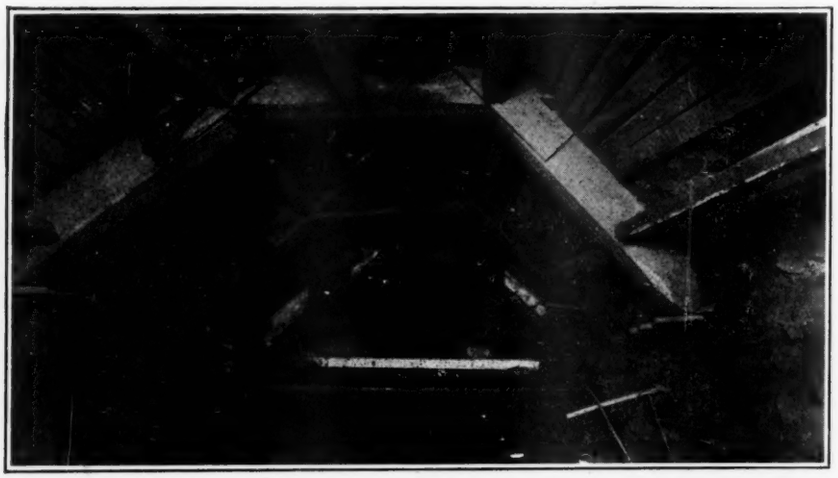
PROFILE OF SHANDAKEN TUNNEL AND CATSKILL AQUEDUCT, WITH RESERVOIRS

has been using more than the safe yield from this watershed. Under this heavy draft the Ashokan reservoir has on several occasions been greatly depleted, although, owing to the unusually heavy rainfall of the past spring, it was on May 18 within four feet of the overflow. It should be said, however, that water is being wasted from the Croton supply (which formerly furnished New York with most of its water) and that the combined Catskill and Croton supplies will suffice for several years to come. (The Croton supply is being wasted in preference to wasting from the Catskill supply because of the more favorable head of the latter and also because of the rainfall conditions that have prevailed for the past 18 months. Within comparatively few years, however, these combined supplies will fail to be sufficient for the population of the city, which is increasing at the average rate of more than 150,000 persons a year or about 20,000,000 gallons a day, and it is therefore imperative that an additional supply be provided. For the past five years the consumption of water has been increasing at the average annual rate of 32,000,000 gallons daily.

In order to obtain this additional supply, the Board of Water Supply is preparing to secure water from the Schoharie creek. This creek flows away from the city, with high mountain peaks of the Shandaken range between it and the Esopus watershed and the Catskill aqueduct into which the Schoharie water is to be lead. The leading of the water from the north side of the Shandaken range to the south side presented only two alternatives, that of pumping water over the range, or carrying it under the range in tunnel. There could be no question as to which was both the safest and the most economical in ultimate cost, and a tunnel is now being constructed under the Shandaken range for bringing Schoharie water into Esopus creek. The Schoharie water will be discharged into the creek several miles above the Ashokan dam and will flow down the bed of the creek into the Ashokan reservoir.

This reservoir was originally designed and constructed with capacity sufficient to store the waters of the Schoharie as well as of the Esopus, and the aqueduct was also designed with capacity for carrying the combined yield.

One of the questions interesting fishermen on the engineering corps of the water board is pre-



THESE TWO VIEWS GIVE A GOOD IDEA OF THE TUNNEL. THE UPPER ONE SHOWS THE TIMBER BENTS AND LAGGING RESTING UPON THEM. THIS TIMBERING IS KEPT UP CLOSE TO THE HEADING. THE MEN SEEN IN THE BACKGROUND ARE PLACING DRY PACKING ABOVE HE LAGGING. BEYOND THEM ARE MEN DRILLING THE TOP BENCH. A BOTTOM HEADING WAS THEN BEING CARRIED 35 FEET IN ADVANCE OF THE TOP BENCH.

IN THE FOREGROUND ARE SHOWN THE 1 1-4 INCH SQUARE IRON PINS ON WHICH THE TIMBERS REST.

IN THE LOWER VIEW IS SHOWN AN END VIEW OF THE TIMBERING TAKEN FROM THE MUCK PILE. THE MEN SHOWN ARE PLACING DRY PACKING ABOVE THE TIMBERING, WHICH IS ABOUT 15 FEET FROM THE FACE OF THE TOP BENCH.

THIS TIMBERING IS ENTIRELY OUTSIDE THE LIMIT OF THE TUNNEL LINING AND WILL BE LEFT IN PERMANENTLY. IT HAS NOT YET BEEN DECIDED WHETHER OR NOT THE DRY PACKING WILL BE GROUTED AFTER THE COMPLETION OF THE LINING.

sented by the fact that, while the Esopus is a famous trout stream, the Schoharie is well stocked with bass and it is to be expected that these bass will travel through the tunnel and find their way into the Esopus creek.

The tunnel under the Shandaken range is known as the Shandaken tunnel. As originally planned by the Burr-Hering-Freeman report, this tunnel would have been about 10 miles long. In endeavoring to find a suitable site for a dam across the Schoharie, successive positions from point to point down the Schoharie creek were investigated until finally one was located at Gilboa, about 8 miles below the original tentative location. This increases the length of tunnel to something over 18 miles—95,530 feet—thus, of course, adding considerably to the cost. In compensation, however, it considerably increases the area of watershed above the dam and consequently the amount of water which can be obtained. The dam now under construction at Gilboa is known as the Gilboa dam. The area of watershed above the dam is 314 square miles, which is 57 miles greater than that of the Esopus shed, tributary to the Ashokan reservoir.

These two features, the Gilboa dam and the Schoharie tunnel, constitute practically the whole of the Schoharie development. The basin of the Schoharie reservoir does not rise to any saddles or low places requiring dikes to prevent the escape of the water, as does the Ashokan reservoir. The reservoir will have a total storage of only 22,000,000,000 gallons and will be used more as a diversion reservoir and an equalizing reservoir for temporary storage of flood waters than for long-time storage of the water, the latter service being performed by the Ashokan reservoir. The Schoharie reservoir will therefore ordinarily contain only a small proportion of its 22,000,000,000 gallons capacity, the Schoharie water flowing continuously through the Shandaken tunnel into the Ashokan reservoir.

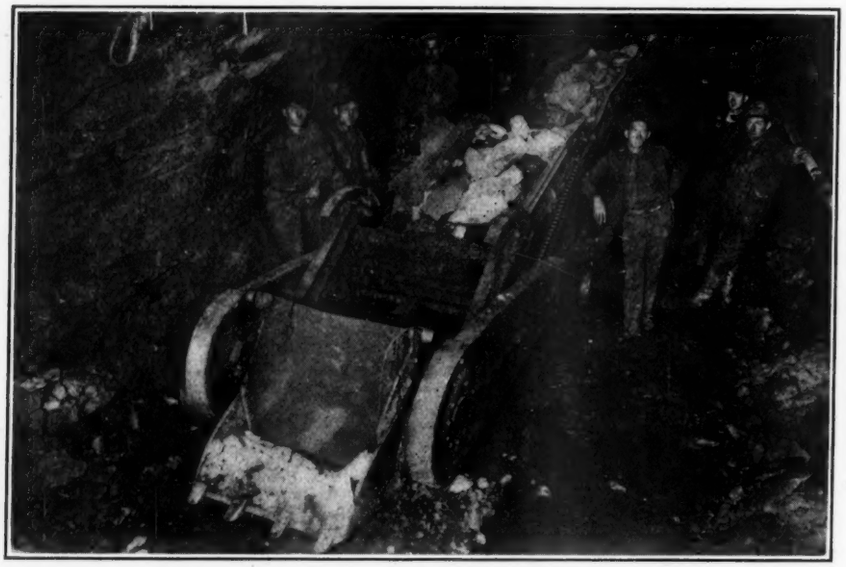
TUNNEL HEADING SOUTH OF SHAFT NO. 6

DRILLING IN THE SOUTH TUNNEL. THE ENTIRE SECTION IS DRILLED HERE AT ONE TIME, USING FIVE "WATER LEYNER" DRILLS MOUNTED ON TWO VERTICAL COLUMNS

Construction upon the Gilboa dam is well under way, and that of the Shandaken tunnel has progressed to a total excavation of approximately five miles. The construction of the dam will be described in a later article. The present will be confined to work upon the tunnel.

THE SHANDAKEN TUNNEL

The hydraulic gradient of the tunnel falls 4.0 feet per mile, and the tunnel follows this through the greater part of its length. In order, however, to keep it throughout in solid ledge rock, the first 18,000 feet is below the gradient and consequent-



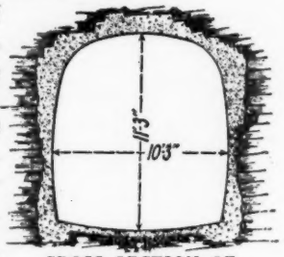
IN THE NORTH TUNNEL AT SHAFT NO. 6. "MYERS-WHALEY NO. 4" TYPE MUCKING MACHINE READY FOR OPERATION BY A 20-HORSEPOWER, 220-VOLT, 60-CYCLE, 49-AMPERE, CONTINUOUS MOTOR. THE MUCKING MACHINE CONSISTS OF A SMALL SHOVEL WHICH THROWS THE MUCK ONTO AN ENDLESS BELT CARRYING IT TO THE REAR WHERE IT FALLS INTO THE MUCK CARS. IT IS POSSIBLE WITH THIS MACHINE TO LOAD A 1 1-2 CUBIC YARD CAR IN ABOUT TWO MINUTES. THE MOTOR IS UNDER THE ENDLESS BELT. THE VIEW IS TAKEN FROM THE TOP OF THE MUCK PILE.

ly under pressure. More than 150 borings were taken along the proposed line of the tunnel to determine the nature and depth of the rock below the ground surface. They showed the rock to be of sandstone and shale throughout the entire route of the tunnel, and in most places for several hundred feet above the tunnel gradient. Near the north end, however, the borings revealed a pre-glacial gorge crossing the line, and the drop in the tunnel grade referred to was made to provide a roof of solid rock above the tunnel, which roof is at least 70 or 80 feet thick at the lowest point of the gorge. This drop brings the tunnel about 135 feet below the hydraulic gradient.

Near the south end the tunnel dips so as to bring its roof slightly below the hydraulic gradient, forming a "running trap"; the object being to cut off access to the tunnel from the end and to prevent wind blowing into it.

The rock strata throughout the entire length of the tunnel are apparently continuous, and dip downward toward the south at an angle of approximately 5 degrees with the horizontal, measured along the line of the tunnel.

The gravity section of the tunnel is approximately horseshoe shape with a maximum horizontal diameter of 10 feet 3 inches and a maximum vertical diameter of 11 feet 6 inches. Where below hydraulic gradient the shape of the tunnel is slightly modified by rounding the lower corners, producing a section considered to be a little stronger to resist internal pressure. On account of the horizontal stratification of the rock, the roof is made flatter than is generally found in horseshoe sections. The capacity of the tunnel is calculated at 600,000,000 gallons a day with a velocity of flow of 8.7 feet per second or 5.9 miles per hour.



CROSS SECTION OF SHANDAKEN TUNNEL

The alignment of the tunnel is not straight, but winds somewhat from a bee-line in order to take advantage of favorable notches in the hills for the location of shafts. There are seven shafts along the line of the tunnel, a portal at the south end, and an intake shaft at the north end about mid-length of the Schoharie reservoir. These shafts vary in depth from 320 feet in shaft No. 2 to 630 feet in shaft No. 5, except that the intake shaft has a depth of only 175 feet.

The shafts all have permanent lining and will be covered with a stone head house. This will furnish access to the tunnel at intervals of 1½ to 2¾ miles, for inspection or repair. At the intake shaft will be a head house nearly 200 feet long, containing the residence of the keeper and appliances for operating the screens, and the valves controlling the intake openings, which are located to draw from two levels.

As a result of studies in economical working based on progress actually obtained and on the requirements as to the time of the completion of the entire tunnel, the contractor is not working the tunnel from shaft No. 2, but plans to connect between shafts No. 1 and No. 3; unless delays in tunneling should make it necessary to increase the number of headings in order to complete the work within the time limit. He also decided not to work the tunnel from the south portal, but to complete the south end of the tunnel from shaft No. 7.

CONSTRUCTION METHODS

The contract for the entire tunnel was awarded to the Degnon Contracting Company, but last November this company assigned the work to the Shandaken Tunnel Corporation, which is now carrying it on. The contractor has approximately $1,000,000 invested in plant for this work, located chiefly at the shafts and in the tunnel. The rock and other conditions, except depth of shaft, being practically the same throughout the work, both plant and methods are practically the same at each shaft and heading, except for shaft No. 6, which will be referred to later.

The total depth of the seven shafts is 3,238 feet. The shafts are lined with concrete and are 14 feet in diameter. The excavation required removing about 8 cubic yards of rock per vertical foot, or a total of 27,600 cubic yards for all the shafts. The shaft sinking was done by the S. J. Harry Company.

The theoretical excavation for the tunnel is 5.7 cubic yards per linear foot, or a total of 565,000 cubic yards. However, where the engineers decide to place permanent roof timbering above the lining, the excavation is increased to approximately 7 cubic yards per linear foot.

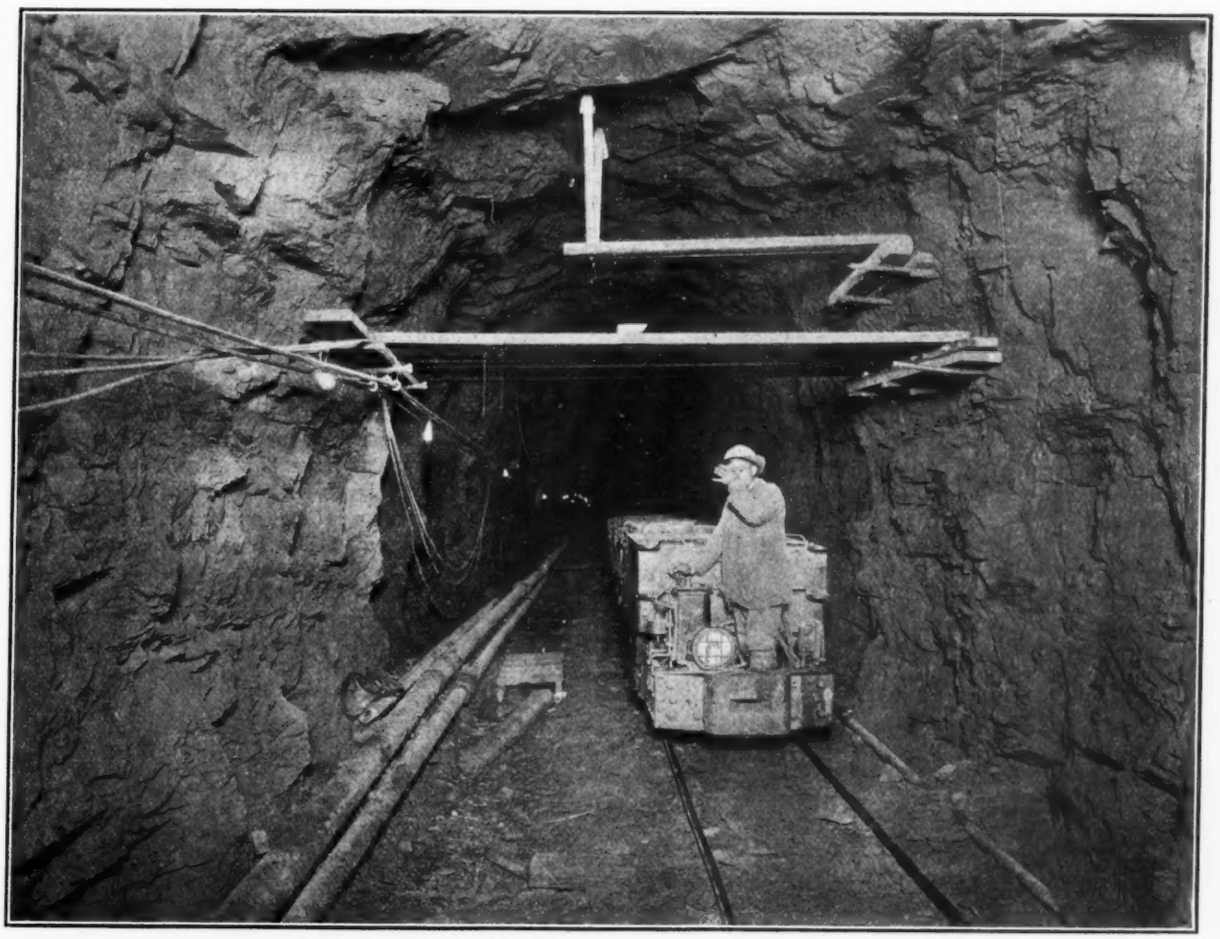
The rock in the tunnel has not, in general stood up as well as was expected and it now seems probable that about 30 per cent will require timbering. The rock breaks well to line so that there is little unnecessary material removed beyond the designated excavation limits.

Work has progressed over one mile north from shaft No. 1 and to varying distances from the other five shafts, the tunnel not being worked at all from shaft No. 2, as before stated.

In all except shafts No. 4 and No. 6 the tunneling is done by top heading and bench. At shaft No. 4 the bottom heading and top bench method is being employed. The rock is sufficiently sound that it is not probable that any lining will be done until after the entire completion of work at a shaft. In the ground that does not require support progress is at the rate of about 14 feet a day at each heading. In general, 10 line holes are drilled and 8 relief holes, all 8 feet deep, and 6 cut holes, all 9 feet deep. The holes are fired at 7 in the morning and 5 or 6 in the evening, the work being carried on in two shifts a day.

The work is under the immediate charge of George G. Honness as department engineer, J. Waldo Smith being chief engineer of the Board of Water Supply and Thaddeus Merriman deputy chief engineer. The work is divided into three sections, each in charge of a division engineer. The Allaben or southern division is in charge of Chas. M. Clarke; Wm. B. Hunter is in charge of the Prattsville or northern division of the tunnel, and James A. Guttridge is division engineer of the Gilboa division.

(To Be Continued)



IN THE SHANDAKEN TUNNEL, NEAR FOOT OF SHAFT NO. 1

On the left is the 6-inch ventilating pipe running nearly to the heading. Beside this is a 4-inch pipe furnishing air to the drills. On the right is a 2-inch pipe carrying water from the compressor house to the "Water Leyner" drills. In the foreground is a train of muck cars hauled by a "General Electric" locomotive having two 5 horsepower, direct-connected, 110-volt motors; the storage battery has 48 cells. Above this is an instrument platform with brass scale showing in the roof. The wires shown are a 220-volt, 3-line system which carries the lights and furnishes the power to the mucking machine About 500 feet from the heading is a small transformer which steps down the voltage to 110 volts. This furnishes power for the lights in the heading, the rest of the lights being on a 220-volt line. There is also a small transformer about 500 feet from the shaft which steps down the voltage to 110 volts for charging the storage batteries of the electric locomotive. The three lower wires shown are "dead" and will be removed. The rock is a hard gray shale and shaly sandstone.

Relations Between Rainfall and Runoff

Conclusions derived from investigations and studies conducted by the Miami Conservancy District. Effects of surface slope, intensity of precipitation, absorption by vegetation, soil storage cultivation, evaporation and other phenomena.

Of the several most valuable treatises on the technical features studied in connection with the flood control work of the Miami Conservancy District, the latest (which has just appeared) is entitled "Rainfall and Run-off in the Miami Valley." This report was prepared by Ivan E. Houk, district hydrographer.

It discusses the rainfall and run-off records for the valley, experiments on run-off and soil moisture conducted at Moraine Park, experiments with artificial rain (sprinkling) there and at Taylorsville, rainfall and run-off during the 1913 and later floods; and finally the plan employed by the district engineers for forecasting floods.

A brief summary of the conclusions as to rainfall and run-off relations arrived at as a result of these studies is given in the report in the following words:

Rainfall and run-off relations have been studied extensively during recent years. While more or less progress has been made, in methods of investigation as well as in final results, the problem is still far from a complete solution. Early investigators frequently tried to express run-off as a percentage of rainfall; more recently run-off has been considered as a residue remaining after the various losses are supplied. This was undoubtedly a step in advance, since run-off is, essentially, a residue remaining after the demands of evaporation, transpiration, and deep seepage are filled. However, these quantities, themselves, are so variable and are affected by so many factors that no simple accurate formulas for their calculation can be developed. It must be recognized that there is no simple relation between rainfall and run-off and that run-off can be determined from rainfall within narrow limits, only after very careful study of all existing data by experienced hydraulic engineers. Even then the results may be considerably in error.

It will be valuable to point out briefly the more general conclusions regarding rainfall and run-off relations in the Miami valley, which seem to be justified by the data collected.

The Moraine Park records show:

1. That variations in surface slope are of much less importance as affecting run-off than are variations in vegetable cover.

2. That intensity of precipitation has an important effect on the occurrence and amount of surface run-off.

3. That during the summer months rainfall seldom percolates to such depths that it is not raised again by capillarity or by root action and evaporated or transpired back into the atmosphere.

4. That storage in the surface soil, filled during winter rains, furnishes about 5 inches of water to the summer evaporation and transpiration requirements.

The sprinkling experiments (rainfall effects produced artificially by sprinkling) show:

5. That the rate of surface run-off increases as the rate of precipitation increases, the former being directly proportional to the latter when the surface soil is saturated.

6. That the rate of percolation, when the surface soil is saturated, increases as the rate of rainfall increases, the variation being according to a straight line equation and the rate of increase being proportionally greater for loose loamy soils than for heavy clay soils.

7. That cultivation has a relatively important effect in reducing the amount of surface run-off.

The studies of annual run-off show:

8. That annual evaporation, including transpiration, is not constant, but varies with the seasonal distribution and amount of rainfall, as well as with other meteorological factors, the variation for the drainage area above Dayton being slightly greater than the variation in annual rainfall.

9. That annual run-off is much more variable than either annual rainfall or annual evaporation.

10. That annual surface, or flood, run-off is much more variable than the annual low water, or ground water, run-off, the variations in total annual run-off being caused primarily by the variations in surface run-off.

11. That the character and condition of the soil influences run-off to a greater extent than has been generally recognized, and next to rainfall is the most important factor affecting run-off.

The studies of storm rainfall and flood run-off show:

12. That the total retention during similar storms is greater in the summer than in the winter.

Some of the above conclusions are simply confirmations of recognized laws. Others, however, such as number 6, relating to the rate of percolation, are new.

It is believed that the sprinkling method of investigating rainfall and run-off relations offers distinct possibilities; and it is hoped that other investigators will try this out in different parts of the country and on different soils. Of course whenever sufficient funds are available it would be desirable to install lysimeters so that the percolation can be directly measured. Such experiments might be taken up by senior or graduate

students at the various technical colleges. Persons desiring to pursue the matter might secure rainfall and run-off data for different soils, at different seasons of the year, with different surface coverings, and in different stages of cultivation. Data might also be secured on the intensity and duration of precipitation which will cause surface run-off to begin on different soils, covered with different growing crops in different stages of growth. Engineers engaged on projects requiring a knowledge of rainfall and run-off relations can probably secure valuable information in a few months by such methods.

Better information regarding variations in soil absorption, percolation, evaporation, and transpiration caused by variations in soil texture, soil moisture, temperature, rainfall, surface conditions, and so forth, will be of material assistance in studies of flood run-off and storm rainfall. Probably future studies of the relation between rainfall and run-off will give better results if the flood run-off and low water run-off are considered separately, even though the division between the two may have to be more or less arbitrarily made. This should be especially true where the flood run-off constitutes a large proportion of the total and is as variable as it is in the Miami Valley.

Records of total rainfall and run-off should be published whenever possible, since such information always is valuable to hydraulic engineers. From a large accumulation of such records certain generalizations sometimes can be made. Where the records are of long duration they furnish valuable data for studies of abnormally dry and wet years as well as of the general variations in total amounts. However, such data are of limited application in that they include the cumulative effects of the different fundamental laws affecting these phenomena, and it is doubtful whether a detailed study of such records will indicate very definite relations between the two which can be blindly applied to other drainage areas.

Concrete Injured in Transit

Although the mixing of concrete for highways and pavements at a central plant and distributing it with trucks or cars has many theoretical advantages, there are possible disadvantages also, and this method should be undertaken with care and good judgment and the details should be carefully approved and operations continuously inspected to insure good results. Notable successes have been attained in several places, as for example in Philadelphia, as illustrated a few months ago in these columns, where satisfactory mixing and placing of concrete was described for work for which the contractor established a central storage and mixing plant, and hauled the wet concrete five miles in automobile trucks, depositing it in good condition with little or no tendency to set before it was placed in sub-grade.

If the concrete is not mixed to the proper consistency, if it is not well mixed or if the time of transportation is too long, it may either become set before it is put in place, or it may be subject to serious segregation. Both of these evils befell concrete being used for highway construction on Federal Aid Project 2 in Illinois, where it was necessary in some cases to remove the segregated portions of hardened concrete from th truck body with pickaxes, involving a considerable loss of time and delay to the work besides the waste of the material. Such difficulties can be obviated by proper mixing, transportation and rapid operation.

Water Works Reports and What They Should Contain*

By R. E. McDonnell†

Why a report should be made; what its appearance and contents should be. Its advertising and educational value.

Some water works superintendents and occasionally city officials, may question the value of a water works report and doubt if it is money well spent. The answer to this question is simple. It depends upon the report.

Water works reports reflect exactly what the superintendent or manager is. Invariably a good superintendent issues a good report. When one examines, as I have recently, a report that contained page after page of fire hydrant locations and another where pages were devoted to statistics fifteen to twenty years old, it doesn't require an efficiency expert to figure out the loss and waste of time and money by issuing such a document. The printer's proofreader was probably the only person who read the entire document. My criticism of water works reports comes from reading them and, therefore, from the standpoint of the consumer, I am going to briefly mention a few features of reports that have made them especially interesting to me.

Why Should a Report Be Made?—a water plant is one of the chief assets of a city; in value it ranks well toward the top of all the city investments, whether owned by the city or company. The success and continued operation of all other industries, factories, etc., are dependent entirely upon the water works. The health, growth and prosperity of the city are entirely dependent upon the purity and cleanliness of its water supply. Its customers extend over the entire city, its commodity sold is standardized and is of one quality. When city owned, every citizen of the town is a stockholder and, therefore, a report to the public is due them and the public further has a right to demand a real water works report, in keeping with the importance of the utility.

Appearance of Report.—Reports, like people, are often judged by appearances and, therefore,

*Paper before the Southwest Water Works Association.
†Of Burns & McDonnell Engineering Co., president of the Society.

it should have an attractive cover and be of a good quality of paper and printing. Like a girl's skirt, it should be long enough to cover the subject, yet short enough to be interesting. The pictures accompanying a magazine article always produce a desire to read the article and photographs and cuts should be freely used to relieve the monotony in printing and statistics.

What It Should Contain.—A brief historical sketch giving date of purchase or date when built and the present value of the property, is always of interest to new customers.

Statistics themselves are rarely read by the layman and these should be converted into graphical diagrams which are understood at a glance.

A concise tabulation of operating costs, annual revenue, fuel costs, increase in number of connections, etc., shown both by figures and graphical charts, are always interesting, but these should not cover more than a ten-year period, as old statistics are of little interest or value.

A population curve and water consumption curve are always well worth the making, as they show what future provision for growth should be made.

A plain statement from health authorities regarding purity of water with percentage of bacteria removed, with cuts or illustrations of bacterial comparison of raw water and treated water, is the best kind of advertising a report can contain, for one must not forget that his business is selling water and the reports help sell the customer.

People always like to know how their money is spent and a graphical diagram showing what part of a dollar goes for interest, labor, fuel and operation is enlightening.

Illustrations showing losses by leaky faucets, bad plumbing and unregulated flush tanks or sewers are helpful in bringing about reforms. Showing customers how much their own bills could be reduced by eliminating all wastage is convincing.

The reduced pumpage, reduced fuel or power bills and increased revenue by universal meter system are features that can and should be shown in every water works report, for even in this enlightened day we find a few communities who still sell, or rather give water away, without meter measurement. The city, corporation or individual doesn't exist that can make a success of selling any commodity without measurement of the amount sold.

The report should show or account for the loss between water delivered and water sold and if this doesn't show a yearly improvement, something is radically wrong and needs correction.

A water works plant is never finished or completed and the needed extensions, betterments and improvements ought always be prominently shown in a report, then there are no shocks or surprises and if bonds are needed there is nothing gained by concealing the fact. Show in the report why the improvements are needed and what advantages and results will be gained by them.

Every report ought to show the cost of delivering water per 1,000 gallons, including interest, depreciation, sinking fund reserve, etc. This infore the public their needs and caused a keen interest in their own utilities. Extracts from reports are desired by the local papers and should be given them. Send each customer one by the meter reader or hand them out by the window collector. Exchange your reports with the officials of other cities of your state.

The water works plant is the chief asset of the city but there is lack of general knowledge concerning it, a fault that we can largely correct by getting out and presenting a genuinely interesting report. Whether it pays or not depends on the report and its presentation.

provements, as a basis for argument for equalizing rates or in securing a raise of rates it is of much value.

A report to be of any value must be interesting, for if not interesting it will never be read. The author of the report or some water works official should personally present a resume of his report before every civic organization of the town, not omitting the women's clubs.

In Glasgow, Scotland, which city prides itself on being the best governed city in the world, the head of each utility or department is required to give, at mass meeting, a public accounting of his utility. For example, the water department head gives the workings of the department, its needs, etc. I listened one night to an address by Thos. Melvin, manager of the sewerage department, on the subject of "The Cleansing of the Clyde River." He told how the Clyde river had been transformed from a foul sewer-like stream to a beautiful river abounding in fish and lined with house boats. The lecture, or really his report, was illustrated with slides and was of much interest. These reports, thus presented, kept beformation is not always known by the superintendent himself and when he figures it out he will in many towns, find that large users, railroads especially, are getting their water at less than its cost of production. When one glances at his own railroad and pullman expense these times, it causes the reflection that railroads ought to have sufficient funds available to at least pay for the cost of furnishing water. In these days of regulation of rates, one cardinal law acknowledged by all is that the rates of each utility, whether a water plant, light plant or railroad, should be based on its value and cost of operation. The railroads or other large users are not mercenary institutions with rates made because of their being a special aid or help to a town. Every report should show what the rates should be to earn this interest, depreciation and operating expenses.

Value of a Report.—It is of much advertising value to the entire community, so much so that many commercial clubs are joining in the expense of printing and circulating water works reports. Every live water works superintendent knows the advertising value to himself of getting out a good report. It places him in a favorable light before many other communities where opportunities for advancement are existing.

The educational value is of greatest importance. It acts as an aid in getting bonds for needed im-

Operating a True Siphon*

The water supply of Hallowell was originally obtained from a brook about 1.5 miles northwest of the city. Two small reservoirs were constructed on this brook and a 6-inch pipe laid from the lower reservoir to two distribution reservoirs just west of the built-up portion of the city. This pipe has its intake about 8 feet below the spillway level, crosses a valley perhaps 40 feet lower and, about 6,000 feet from the reservoir, crosses a ridge where the pipe at its highest point is about 3 feet above high water in the reservoir. From this point the pipe descends sharply to the distribution reservoirs, which are about 41 feet lower than the impounding reservoir. In order to have sunk the pipe below the hydraulic gradient it would have been necessary to excavate the trench through 500 or 600 feet of rock.

The consumption exceeded the supply from this source some years ago, and an emergency connection was made with the pipes of the Augusta water district, and after a time the operation of the siphon became so unsatisfactory that the entire supply was taken from Augusta. During 1918, Hallowell used an average of 210,000 gallons a day, paying Augusta $5,367 for the year's supply.

Prior to its practical abandonment, the method of operating the siphon had been as follows: valves at the inlet and discharge ends of the supply pipe were closed; the air valve at the summit was opened and a supply of water from a small reservoir 20 or 30 feet higher was drawn through a 2-inch pipe into the 6-inch pipe, thus filling the siphon and driving out the air. When all the air had been expelled at the summit, the air valve was closed, the supply cut off from the upper reservoir and the gates at the inlet and discharge ends of the pipe were opened. The siphon then continued to operate without attention until a sufficient quantity of air had accumlated at the summit to prevent its operation. The efficiency of the siphon began to decrease almost immediately and gradually fell off until the flow practically ceased. It was the custom to manipulate the valves at 7 and 11 a. m. and at 4 and 7 p. m., and operating in this way, the siphon worked with a fair degree of success.

The use of the siphon was finally abandoned when the 2-inch pipe used for filling the siphon finally gave out. Owing to the cost of purchasing water from Augusta, it was decided to determine whether the siphon could not again be used and the firm of Metcalf & Eddy was consulted in the matter. They found the Hallowell water supply of excellent quality. The cost of excavating the rock to lower the pipe below the hydraulic grade line was practically prohibitive. It was then suggested that possibly some automatic means could be provided by which air could be removed from the summit as it accumulated. Electric power was readily available from a power line which crossed the summit near the pipe line and there seemed no reason to doubt the practicability of providing an automatically controlled air pump for removing the air.

No definite information was available as to the amount of air to be removed, except the fact that the siphon had formerly operated for 4 or 5 hours without recharging. The matter was taken up with C. O. Rogers, engineer for the Charles J. Jager Co., who suggested an equipment consisting of a receiver, 24 inches in diameter by 36 inches long, of reinforced steel, with supporting cradles and a 6-inch flange yoke; a water glass and fittings for indicating the water level in the float chamber; a copper deposit float with necessary connections for the operation of a float switch; a triple pole float switch of the enclosed type; a Gardner compressor unit, 3 by 3½ inches, air cooled, with extended motor base and belt and idler drive. Capacity of compressor, 8 cubic feet free air per minute; a 1½ horsepower, 3 phase motor, 1,800 r. p. m. for 220 volt current.

Such an equipment was purchased and placed in a vault 12 feet long, 6 feet 6 inches wide and 8 feet deep, which was built enclosing the pipe at the summit. A tee branch was connected into the pipe and the air tank or receiver was mounted upon this tee. The cost of the vault, including considerable rock excavation, was about $800, the equipment cost $643, and the installation and connection of the apparatus about $100, giving a total cost of something under $1,600.

This apparatus was put in operation on December 15, 1918, and had been in continuous operation when this paper was written, about two years later. The operation is entirely automatic and the siphon is maintained in continuous operation. It is, of course, necessary to throttle the valve at the discharge end of the supply pipe where it enters the distributing reservoir in order to prevent breaking the siphon because of the excessive drop in the lower leg and thus avoid depleting the reservoir too rapidly.

During 1919 the cost of electric power for operating the pump was $85 at 9 cents per k. w. h. and in addition, $9 was paid for electric lights in the vault, making the total cost of current for the year $94. Interest and depreciation on the investment at 7 per cent would give $112 per year, or a total cost of operating the siphon of $206. Even with the siphon operating, some water had to be obtained from Augusta to supplement the inadequate supply, for which the city paid that city $2,146. This makes the total cost of the water supply for that year $2,351, or $3,016 less than when all the water was purchased from Augusta.

When the apparatus was first installed the pump operated about once an hour, but when water in the reservoir became comparatively low much more air accumulated, and in July, 1920, the pump was found to be operating about once in five minutes, the difference in water level in the receiving tank between time of starting and stopping the pump being about 6 inches, which corresponded to an accumulation of air of approxi-

*Condensed from a paper before the New England Water Works Association by Wallace R. Brann, superintendant of water works of Hallowell, Maine, and Charles W. Sherman, of the firm of Metcalf & Eddy.

mately 3 cubic feet. The greater amount of air to be removed at this time may be due to more air entering the pipe at the inlet end in solution or in suspension in the water, possibly to air drawn in through the joints of that part of the pipe which is above the hydraulic grade line and also above ground-water level, more of the line being above such level during periods of low water in the reservoir.

The pump maintains a vacuum of about 24.5 feet of water. The hydraulic grade line at the siphon is therefore about this distance below the pipe at the summit of the siphon.

In discussing this paper, members referred to several other siphons. Frank A. Barbour told of a siphon put in at Woburn about 10 years ago connecting about 25 driven wells with a suction well, the high point being immediately over the well and the air being removed from it by a reversed air compressor. This was a 14-inch pipe about 1,400 feet long.

Edwin C. Brooks told of a 30-inch cast-iron pipe line owned by the Cambridge water works which rose above the hydraulic gradient at one point, but seemed to work perfectly for a time. Then it commenced to fail and on being dug up most of the laid joints seemed to be loose although they had been faithfully driven. These joints were then driven up. Soon after that a new line was built and this section was put out of service.

D. A. Decrow told of a 24-inch pipe 9,000 feet long, laid in 1885 in Auburn, N. Y., and used as a siphon, the high point being about 9 feet above the gradient. It had been intended to lay this at grade, but the pipe was kept up to avoid excavating in quicksand. Some provision was made for removing air at the high point and it delivered six or seven million gallons a day without difficulty.

Water-Borne Typhoid in West Virginia

Epidemics due to use of untreated river water or polluted well water, to filter plants run by careless or ignorant operators, to the interruption of chlorine treatment, or to pure negligence.

Under the title: "Reducing the Typhoid Toll in West Virginia," a pamphlet has been issued by E. S. Tisdale, director of the Division of Sanitary Engineering of the West Virginia Department of Health, in which he reviews the accomplishments of that division during the five years since it was organized. Due to defects in the registration laws of the state, complete records of typhoid cases and deaths in different parts of the state are not available, and Mr. Tisdale states that "the only way in which the progress could be clearly seen is by a study of the towns and cities where typhoid outbreaks have occurred. By noting the prevalence of typhoid in these towns now as compared with previous times in the past, we can arrive at a fairly definite conclusion as to the progress which has been made."

Nineteen different typhoid outbreaks attributed to water have been investigated by the division. The report divides these into four groups, the first consisting of typhoid outbreaks caused by the use of untreated river water; the second consisting of epidemics due to failure of filtration plant to function properly; the third, mining camps where the outbreaks were traced to infected wells; and the fourth, outbreaks caused by the interruption of chlorination treatment of the water.

UNTREATED RIVER WATER

The first group comprised St. Albans, Dunbar, Piedmont, West Union, Gassaway, Clay Court House, Rowlesburg, Spencer and Philippi. Six of these were given immediate relief by the installing of an emergency chlorinating plant by the State Department of Health, which owns two emergency plants of this kind. (In addition to keeping these emergency plants, the department keeps on hand spare parts for such plants of both wet feed and dry feed type, which are loaned to communities using chlorine until they can be replaced by parts obtained from the manufacturers.) In each of these towns the typhoid outbreak was traced to the water, which in one case was served to the people through the medium of ice cream and soda water, in preparing which a local drug store used a public supply which was not intended for domestic consumption, the homes all being supplied with wells.

POORLY OPERATED FILTER PLANTS

The second group included Charleston, the capital of the state, Williamson and Weston, two epidemics having occurred in Charleston. This city was served with water that was treated by a filter plant which was being run by operators who "were ignorant of the real danger, besides having no adequate conception of the operation methods of a modern filter plant, the proper use of the alum or the correct amount of chlorine dosage." A typhoid epidemic occurred in the summer of 1917 and was investigated by both the state department and the United States Public Health Service. The recommendations of these were not carried out and a second epidemic occurred in the summer of 1918.

In the 1917 epidemic there were 210 cases and 10 deaths, and in 1918 168 cases and 31 deaths. In the latter year there had been a rapid increase of residents because of war activities, and disastrous fires had heavily overtaxed the filter plant, with the result that impure water was pumped into the mains. In 1917 the company had employed an expert bacteriologist and chemist, but owing to the refusal of the ignorant filter operators to follow his directions, the plant was not operated effectively. Following the second

outbreak, city, state and federal authorities united in their demand for action by the water company and emergency wooden filters were hurriedly constructed, the rate of chlorination raised to approximately one part per million, and a competent consulting engineer was employed by the water company to design a new million-gallon sedimentation basin, additional filters to double the capacity of the plant and suitable pumping equipment. The new plant is now in operation, better trained filter operators are at work under a competent chemist and bacteriologist who makes daily tests and files weekly reports with the State Department of Health, and chlorination at a rate of 0.5 part per million is maintained, with the result that a safe water is being supplied. The result has been a reduction of the typhoid death rate to 14 in 1919 and 3 in 1920, while the reduction in cases has been even greater.

In Williamson, the rapid filter plant was not provided with a sedimentation basin, and hypochlorite as well as alum was being introduced into the suction line of the pipe that raised the water from the river to the sand filters. During the winter, when the stream was muddy, this plant could not purify adequately and the number of cases of typhoid usually increased.

In Weston there was a serious typhoid epidemic in 1919 due to the breaking down of the filter plant in the spring of that year and 40 or 50 people in this town of 4,000 contracted typhoid fever during the summer while the filter plant was not operating properly. Since 1916 the water had been treated with liquid chlorine. During 1918 and the spring of 1919 the superintendents at the plant were incompetent, rapid deterioration took place, the filters were abused, chemicals improperly applied, the motors for the pumps burned out, the chlorinator fell into disuse, and, in short, the whole plant was reduced to a mass of junk and practically raw river water was pumped to the reservoir. The State Health Department took emergency measures, including having a new chlorinator installed and later the entire filter plant was overhauled, new sand and gravel placed in the filter, chemical tests were started to control the amounts of soda and alum and regular daily records of filter operations are kept accurately and filed weekly with the State Department of Health.

POLLUTED WELLS IN MINING CAMPS

The state department was called in by the physicians at Ronda, a mining camp, when 15 cases of typhoid occurred in a community of 230. These obtained their water supply from a dug well that was not protected by a curb or otherwise from the entrance of surface water. The well was closed and a new supply provided. In Ivaton, another mining camp, 8 cases were reported in December and were traced to a poorly protected dug well. As no other source of supply was available, water from this well was disinfected by use of hypochlorite of lime, the well was thoroughly cleaned out and protected against surface drainage. In the spring the mining company installed a new supply from a deep drilled well.

The most severe outbreak in a mining camp was that at Loma. Here the supply was from drilled wells which, however, had not been capped and there was no protection against surface drainage. Sanitary conditions generally about the camp were very bad and flies were breeding by the millions. There was a general slope of the ground toward the well that was used by most of the people in the camp, and following heavy rains 35 of these contracted typhoid fever and 4 deaths occurred. Here the wells were disinfected with hypochlorite of lime and were capped tightly and protected by a concrete slab. In addition, the customary sanitary precautions were taken throughout the camp.

INTERRUPTION OF CHLORINATION

In the fourth group, Elkins with a population of 7,500 had over 100 typhoid patients in March, 1918, in spite of which it was only by accident that knowledge of this reached the State Health Department. Investigation by the department showed that the city authorities for more than two months were unable to obtain chlorine gas for the chlorinator and untreated water was pumped into the city main without the people being notified of the fact. During this time the winter rains brought a great deal of pollution into the river from communities above, where there had been typhoid fever. A supply of chlorine gas reached the city the same day as the engineer of the health department, and the water system was immediately flusned out, including the intake well, reservoirs and distribution system, and the use of chlorine was renewed with a high rate of dosing in order to remove any possible infection that might remain in the distribution system. There was no filtration plant here; had there been, it is believed the epidemic would have been much less severe, if it had not altogether been prevented. The city has had plans for a filtration plant prepared.

Fairmont had 195 cases in three months in 1918. Here a filtration plant had been built in 1906, but was wholly inadequate for present conditions and was being entirely by-passed. Incidentally the state department reports that Fairmont paid $300,000 for this filter which was simply an experiment of its engineer, the theory being that water could be filtered by passing either upward or downward through it. A chlorinator had been installed in 1916, but was unsatisfactory, and had been boxed up ready to return to the factory and the city was receiving river water without any treatment. A new chlorinator was obtained as soon as possible and has been conscientiously operated since that time, while complete plans have been prepared for a modern water purification plant.

Clendenin was supplied with river water which was chlorinated, but heavy rains on the watershed caused the river to carry much mud and leaves which clogged the strainer in the chlorinator so rapidly that it was impossible to keep the apparatus running. The chlorinator was shut down for a number of hours when conditions were at the worst and untreated water was pumped into the mains and this was followed by an outbreak of 15 cases of typhoid. "In order to over-

come such clogging of the apparatus in the future, a contrivance was devised which has not only worked admirably here at Clendenin but also has been adopted all over this state where chlorinators are treating raw river waters. On the water-line leading to the apparatus a piece of pipe 8 inches in diameter and 3 feet long was inserted in a vertical position. The muddy water flowing through this pipe became quiet with the result that dirt, sand and sediment sank to the bottom of this stilling chamber, the clearer water passing on to the chlorinator."

The state board calls attention to the absolute necessity for continuous treatment with chlorine gas where this is the sole safeguard of the water supply and therefore urges duplicate apparatus under such conditions. It is, of course, desirable to provide filtration as well as chlorination. At present all persons in charge of water works where chlorine apparatus is maintained are required to mail to the State Board of Health once a week a card giving for each day of the week the gallons of water pumped per hour, the rate of chlorine used and the river conditions. This has been required now for two years past and has proved practical and helpful. "It has stimulated interest in the chlorinator operation by the men in charge and has kept the office in touch with all the chlorine plants constantly." The key to the success of this weekly reporting plan of checking up chlorine treatment has not been the force of the law but the personal contact between the water works official and the sanitary engineers of the department.

PURE NEGLIGENCE

One case is reported by the board which it considers as a class by itself, this being Wheeling, the largest city in the state with a population of 55,000, which, until 1919, pumped the grossly sewage-polluted water of the Ohio river direct into the mains without any treatment. Prior to that time the average death rate from typhoid fever was believed to have been 56.8 per 100,000. Even yet, in the spring of 1921, Wheeling remains an ignominious example of disregard of its citizens' welfare in this respect.

It is estimated that since 1910 there have been in the city 3,300 cases and 220 deaths from typhoid. The city had been urged to take some action, but not until the end of 1918 was the department able to persuade it to install a chlorination equipment. In 1917 the case rate was 200, and was 155 in 1918, but was only 28 in 1919 and up to April, 1920, only 7 cases had been reported. In April, however, the freight embargo prevented the city from obtaining chlorine and there was an immediate increase, 28 cases being reported up to July 1. Even with these experiences to urge haste, however the city has not yet installed a filtration plant although last December the council decided to have preliminary plans prepared for a modern purification system.

The report contains charts showing the great difference between number of typhoid cases in cities supplying raw water and those supplying filtered and chlorinated water. It also has a similar chart showing the superior effect of both filtration and chlorination over chlorination alone. It compares Huntington, with both filtration and chlorination, with Wheeling, which has chlorination alone; the former reducing water-borne typhoid to a very low figure, while Wheeling probably does not eliminate more than 70 per cent to 80 per cent and has a considerably greater number of typhoid cases than has Huntington.

The report concludes with a reference to the death on March 14, 1921, of a member of the legislature who died of typhoid fever on that day, and urges the legislature to pass a budget for the State Department of Health, as recommended by the budget committee, as a memorial to their fellow-legislator.

Outfit for Measuring the Level of Liquids

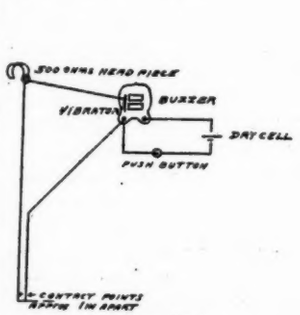
By S. W. Tay

The following is a description of a device constructed for the purpose of gauging the flow of sewage in the Honolulu sewers. Hourly readings were taken with this outfit both day and night at numerous manholes and no trouble was experienced in obtaining accurate results. It was quite easy to read to one one-hundredth of a foot. Errors due to eddies exceeded those due to the apparatus.

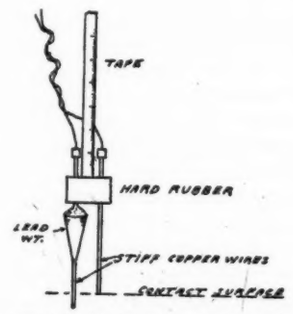
The outfit consists of a wireless head receiver, dry cell, small electric buzzers, push button, engineers' tape, weighted copper contact points with sufficient flexible wire to permit contact points to reach water level. The whole is assembled in an inexpensive imitation leather case.

When in use, the head receiver is placed in position and contact points lowered by means of an engineer's tape attached to them; the operator at the same time is playing out the flexible wires until the points are within a short distance of the water. The buzzer circuit is then completed by pressing the push button. The sound of the buzzer is loud enough to be heard by the operator with head piece on, and he can tell if the buzzer is working properly. He then slowly lowers contact points until a loud buzzing sound is heard in the receiver. The reading of the tape is noted from any convenient benchmark.

The above apparatus was assembled by Dr. A. Romberg, University of Hawaii, for board of engineers composed of A. R. Kellar, Geo. Collins and S. W. Tay.



Wiring Plan.



Sketch Showing Contact Points

COMPACT PORTABLE OUTFIT FOR MEASURING LEVEL OF LIQUIDS BY DAY OR NIGHT

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Ineffectively Operated Filtration Plants

How many water purification plants are ineffectively operated by men who "have no adequate conception of the operation methods of a modern filtration plant, the proper use of the alum, or the correct amount of chlorine dosage?" (This is quoted from a state health department report that is discussed at length in this issue.) That some are, is known. That many more may be, is more than probable.

One of the most important duties of state and federal health authorities is the remedying of such condition wherever it may exist. A water purification plant so operated as to be ineffective is worse than useless, for it gives an unwarranted sense of security to the consumer, it possibly leads to his abandoning the use of a supply that is actually safer than the one which is supposed to be purified but which is not, and a continuous use by the consumers through many years, of a purified water decreases their partial immunity to typhoid and thus renders them more subject to the attacks of typhoid bacilli that may reach them through ineffective purification than they would be had their systems acquired partial immunity by becoming accustomed to drinking water so contaminated.

If it is important to require the licensing of a physician who serves a few hundred patients, how much more important is it that the possession of specified requirements and the obtaining of a license based thereon should be required of those who operate water filters and thus control the health and lives of an entire community? Such regulations should, in our opinion, be enforced by the boards of health of all the states of the country in every community where filter plants are operated.

Importance of Run-off Data

Where there is reason to believe that the supply of water available from a watershed whose use is contemplated is not considerably greater than the requirements, more or less definite knowledge of the amount of run-off is very important for determining whether the yield will meet the requirements. In addition, the average and especially the maximum yield is frequently a matter of vital importance for the designing of spillways, flood protection works or other reasons.

An unusually thorough investigation over a large area has been conducted by the Miami Conservancy District in connection with its project for controlling the floods of the Miami river and its tributaries. The results of this investigation have recently been made public, and the general conclusions are published elsewhere in this issue.

While investigations of this kind are of the greatest value not only for the purposes for which they were made, but also for the general information of hydraulic engineers, it must be understood that few of the specific conclusions from the investigation of a given watershed are generally applicable to other sheds, and even some of the more general laws may be modified in an unknown way by variations in local conditions.

The rainfall on two watersheds separated only by a single range of mountains may vary greatly, and the percentage of run-off likewise vary; while differences in geological structure, in amount of cultivation, of swampy land, in slope or other topographical features, may cause differences in run-off which would not be suspected by those who have not made wide study of the subject.

As an illustration of the different rainfall rates that may be found under apparently similar conditions of location and topography may be mentioned those of the Schoharie watershed of New York's water supply (referred to in the leading article in this issue) and of the Esopus watershed which lies immediately south of it, both being portions of the Catskill mountains. In spite of this propinquity, however, the average rainfall on the Esopus shed is found to be 56.22 inches per year while that on the Schoharie is only 39.48 inches. Nearly as great a dissimilarity is found also in the percentage of run-off on these two sheds. Much greater differences are found in the far west, where the Cascade range causes such heavy precipitation on the westward side that lit-

tle moisture is left in the winds that cross the range, and the lands to the east receive only a percentage of the rainfall found on the western slope.

It is doubtful whether there will ever be a science of rainfall and run-off sufficiently comprehensive and exact to permit an accurate estimate of run-off from any given watershed of large extent without obtaining rainfall records and making run-off investigations on the shed itself.

It is therefore important that city, state and federal authorities systematically collect records of rainfall and stream flow on all the areas under their control, to be used in future investigations and utilizations of watersheds on such area; since the value of such data increases as the square or some higher power of the length of time over which the collection of them has extended.

Tabulated Data on Rates, Finances and Labor

In this issue we publish tabulated data from several hundred cities giving information that was furnished through the kind co-operation of the superintendents or other officials of the water works of these cities, in reply to questions that seemed to us timely. Finances and the labor question are troublesome almost everywhere now, and these replies tell whether cities have increased their rates or in what other way they have met the increased costs, and to what extent the costs have increased. Also they tell how wages compare with those paid before the war.

Many of these replies are exceedingly interesting, and we hope later to give articles enlarging at length upon the facts so briefly stated. Also we expect in a week or two to comment upon the data, summarizing them and basing upon them a birdseye view of conditions throughout the country.

We believe that they contain the latest, most complete and most authoritative collection of facts along these lines that have been published during the past year.

Municipal Waste of Water

Although the water department of Springfield, Mass., is not permitted to charge the city for water used in municipal service, it has installed meters on many of the municipal services, such as schools and other public buildings in order to bring home to the officials the amount of water which it knew was being wasted. In their report for 1920 the commissioners say that this "has called attention of the city authorities in tangible form to the extravagant and unnecessary waste of filtered water in many of the municipal buildings and has resulted in large reduction of such waste in past years.

"It is the policy of our inspection division to keep those in charge of the different city properties informed as to wasteful conditions needing attention and to cooperate with them in the matter so far as may be possible.

"It is believed that the installation of meters on all the remaining unmetered municipal services possible to be metered should be continued and completed as soon as the necessary funds therefor may be available; and that the municipality itself, as owner of the water supply and as its largest consumer, should at all times set a good example to the numerous private consumers in the proper conservation of this most important necessity."

During the year 1920, 93 per cent of the water used in schools was believed to be metered and about 90 per cent of that used in other public buildings, and 73 per cent of that used in public parks. Approximately 157 million gallons were used in schools, 63 million in other buildings, and 55 million in parks. It was estimated that over 96 million gallons were used by the sewer department in flushing, although this was not metered.

The estimated value of all the water used for municipal purposes was $76,459.

Appraisal of Water Works Properties

The Board of Water Commissioners of Springfield, Mass., in 1920 took final action towards securing an appraisal and classification of the water works plant and property, which action had been recommended by a special committee on appraisal after several years of study and consideration. The appraised value was given at $5,385,430, which was adopted as the revised capital cost as of December 1, 1919. There were also adopted certain rates of depreciation to be applied to each of the several classes of structures and other property, to be used as a basis for future depreciation charges and reserves.

Of the total value, $415,144 was for land and easements, $121,612 for buildings, fixtures and grounds, $4,343,517 for structures and equipment and $505,157 for intangible assets.

Depreciation charges are to be deducted annually from this amount, the decrease for 1920 amounting to $90,173.

The rate of depreciation varies with the item to which it is applied, from a minimum of 1 per cent to a maximum of 25 per cent. One per cent depreciation was charged against reservoirs, canals, dams, etc., a sedimentation basin and a stores equipment yard. One and one-half per cent was charged against most of the buildings owned by the department. Two per cent was applied to most of the mains, although two large mains were assigned a 3 per cent rate. Five per cent was applied to a stand-pipe, to lighting equipment, telephone service and certain other items; 10 per cent to a coagulant plant and to shop equipment and tools. Fifteen per cent was charged against team equipment and 25 per cent against auto equipment.

The commissioners have adopted a form of financial statement that is comprehensive but not unduly long and that shows all of the essential financial dealings and conditions of the department.

Meter Rates—Finances—Labor

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Alabama:											
Albany and Decatur	P	$2.00	10	$1.25	10	....	$0.40g	....	....	From surplus	No
Gadsden	M	2.50-2.75	10	1.00-1.50	10	$0.25f	.25f	$34.81	$33.28	Operation cut $5,000 by electrifying plant	No
Jasper	P	3.00	10	....	..	.30g	.30g	....	....	.....	....
Mobile	M	3.50-4.00	9	2.00-2.50	9	.15g-.10g	.15g-.06g	22.65	19.50	Reduced consumption and increased rate	No
Opelika	M	2.00	8	1.00-1.50	10	.25g	.25g	40.00	55.00	From income	No
Arizona:											
Clifton	P	3.50	8	2.00	8	1.00g	1.00g	154.00	139.00	From income	No
Arkansas:											
Marianna	M	2.50	10	1.50	10	.50g	.40g	350.00	120.00	Metering services	Yes
California:											
Anaheim	M	4.00	8	2.25	8	.13 1-3f	.10f	24.00a	....	General fund	No
Grass Valley	M	4.00	8	2.50	8	No meters b	....	b	....	.....	No
Ontario	M	3.20	8	2.80	8	.07½f	.05f	....	....	More efficient methods	No
Oxnard	..	3.50	8	4.00-5.00	8	.08f-.15f	.08f-.15f	....	....	From surplus	No
Palo Alto	M	4.00-4.50	8	2.50	8	.12f	.09f	107.00c	142.00	Increased rates	No
Pomona	P	3.50	8	2.25	9	.16 2-3f	.16 2-3f	Double 1914	....	Reduced force, drew on surplus, borrowed	Yes
Redlands	M	3.50	8	2.75	8	.08f	.07f	21.20	12.50	Increased rates	No
Redwood City	Pd	4.50-5.00	8	2.50	8	.30g	.30g	....	....	From city treasury	No
Sacramento	M	4.615	8	3.00	8	Flat rate	....	13.27	100% greater	.....	Yes
Santa Cruz	..	4.00	8	2.50	8	1.00f	.75f	....	....	.....	No
Watsonville	P	4.00	8	2.25	9	.16 2-3f	.147f	63.00	11.00	Increasing rates, reducing force	....
Colorado:											
Rocky Ford	M	4.00	8	3.00	8	1.35g-.20g	....	95.09	....	Keeping expenses down	....
Connecticut:											
Bridgeport	P	2.70	9	1.75	10	.03-.13f	.03-.13f	....	....	Bonds, reducing force	Yes
East Hartford	M	4.00	9	2.00	9	.15-.30g	.15-.30g	....	....	Sinking fund, reducing force and expenses	No
Naugatuck	P	3.60	8	2.00	9	.15g	.15g	....	....	.....	Somewhat
New London	M	4.00	8	2.00	9	.16-.06g	.16-.06g	56.69e	38.98e	Increased revenue for maintenance bonds for reservoir	No
Portland	P	2.60	9	2.50	9	.25-.13g	.25-.13g	....	....	Reducing force	No
Putnam	M	3.60	9	1.75	9	.25g	.20g	1.00	0.94	Raised rates: bonds for extensions	No
Southington	M	3.60	9	1.75	9	.20-.05f	.25-.06f	27.42f	15.38f	Economy in operation, curtailing new work	Somewhat g
Westport	P	3.00	8	2.00	10	.15f	.12f	87.00	60.00	Electric plant carried deficit	No
Willimantic	M	3.60	9	....	..	.25g	.25g	....	....	.....	....
District of Columbia:											
Washington	M	3.44+.77 bonus	8	1.75	8	.075-.05f	.06-.04f	10.83	4.35	Congressional action	No
Florida:											
Ft. Myers	M	3.50	9	2.25	9	.50-.25+.20g	.50-.20 & .15g	500 per mo.	325 per mo.	Raising water rates	No
Georgia:											
Americus	M	1.25	10	.75	10	.20g	.20g	118.00	59.50	Drawing on surplus	No
Auburn	M	1.50	10	1.00	10	.40 sliding scale g	.25 sliding scale g	120.00	80.00	Cutting down force, taking care of small wastes, increasing rates	No
Augusta	M	2.70	9	1.50	10	.25 less 20% g	.10 net g	20.03	12.01	Reducing waste	No
Bainbridge	M	1.75	9	1.25	10	.10g	.10g	....	....	Reducing consumption & funds from city	Yes
Carrollton	M	2.00-2.25	10	1.00-1.25	10	.33 less 10% f	.33 less 25% f	90.00	60.00	1914-30% metered, 1921-95%	No
La Grange	M	1.50	9	1.25	10	.30-.12g	.25-.10g	10.50	8.50	Surplus	No
Moultrie	M	1.50	10	1.25	10	.25g	.20g	119.00	110.00	Cutting force & other expenses	Somewhat
Quitman	M	2.00	10	1.75	10	.20g	.20g	240.00	100.00	City treasury	Yes

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Georgia (continued):											
Rome	M	2.25	10	1.25	10	$.07½-.15f; .10 to .20g	$.07½-.15f; .10-.25g	$62.50	$34.50	City treasury drawing on surplus, cutting force, reducing consumption	No
Thomasville	M	1.50	10	1.00	10	.18g	.15g	142.00	95.00	By profits from elec. light plant	No
Visalia	..	4.00	8	2.00	8	.12½-.25g	.12½g-.25g	50% higher than in 1914	....	.....	....
Idaho:											
Lewiston	M	4.50	8	2.25	8	.06f	.06f	5.36	6.38	Reducing consumption, through meters	No
Weiser	M	3.80	8	2.50-3.00	8	.20-.08f	.20-.10g	....	....	By transfer, from light and power funds	No
Illinois:											
Bushnell	M	4.50	9	2.75	9	.25g	.25g	85.00	60.00	Reducing consumption & funds from treasury	No
Cairo	P	3.00-5.00	9	1.50-3.00	9	.08-.25f; .07-.17g	....	....	....	Rates raised	No
Carrollton	M	3.00	8	2.50-3.00	8-9	.30g	.30g	....	....	Income from water rentals	Somewhat
Dixon	P	.45 hour	8 & 9	.25 hour	8 & 9	.25½f	.15f	127.00	59.00	Drawing on surplus & loans from banks	No
Herrin	M	6.00	8	2.80	8	.70g	.40g	72.35	....	Increased rates	No
Lincoln	P	3.60-4.00	9	1.75	9	.18-.08; .55.04½f	.22f	.06	.03½	Cutting down maintenance, refusing new extensions or betterments	Yes
Mattoon	M	4.00	10	2.00	10	.06-.40g	.04½-.25g	33.52	22.00	Increasing rates	Yes
Mt. Carroll	P	.40	9	.25	10	.25g	No increase	....	....	.....	Yes
Murphysboro	P	4.00	8	2.00	8	3.68-.07.6g	.25-.05g(h)	....	....	.....	No
Oak Park	..	.55-.65	9	.25-.30	9	.18-.15g	.18-.15g	130.00	100.00	Less employees	No
Pana	M	.50	8	.50	8	.30-.12g	.30-.12g	....	....	w. w. returns placed in other funds	No
Quincy	M	3.00-4.00	10	2.00-2.50	10	.45-.14.4g	same	....	....	.....	No
Rochelle	M	4.00	10	3.00	10	.21-.09f	.21-.07f	....	....	From treasury, reducing force and consumption	No
Rock Island	M	4.00	8	2.10	8	.14-.06f	same as 1921	....	....	Less extensions	No
Waukegan	M	5.00	8	3.00	8	.17-.06g	.17-.05g	....	....	Drawing on surpl., no imprvts.	Yes
Indiana:											
Bedford	M	.45	10	.20	10	.07-.40g	.07-.40g	....	....	Drawing on surplus	Yes
Bluffton	M	4.50	10	2.25	10	.23-.17g	.21-.11g	16,750	12,243	Cutting down force	Yes
Covington	M	3.00	10	1.50	10	.15-.25g	same f	....	....	Using surplus	No
Delphi	..	3.50	10	2.00	10	.07-.40g	same	36.95	90.28	Elec. pumping units in place of steam	No
Elkhart	P	.40	9-12	.15	9-12	.12-.08g	same	14.00	5.00	Draw. on sur. & reducing force	No
Elwood	P	.50	9	.20	9	.28g	.25f	....	....	Pub. Service Com.	Somewhat
Evansville	M	3.60	8	2.00	8	.05-.20g	same	58.82	23.14	Drawing on surplus and reducing consumption	No
Ft. Wayne	M	.50-.60	9	.22½	9	.12-.45f; .16-.06g	.075-.045 f; .10-.06g	.07024	.06984	Reducing consumption	No
Jasonville	M	3.50	9	1.50	9	.35g	.35g	75.00	54.00	Drawing on surplus	Yes
Kendallville	M	3.60	9	2.25	9	.25-.10g	.25-.10g	....	....	More efficient machinery	No
Knightstown	M	.35	9	.20	9	.25-.08g	.25-.06g	90.00	....	Cutting consumption by metering & cutting forces	No
La Porte	M	3.50	10	1.75	10	.10-.04g	same	49.89	36.26	.....	No
Lebanon	M	4.50	9	2.75	10	.14-.25g	.10-.25g	1.56	.75	.....	No
Linton	M	5.00	9	2.00	9	.12½-.43g	.10-.35g	....	....	Increase in rates	No
Mishawaka	M	.40	9	.22½	10	.10f	.09f	....	....	.....	....
New Albany	P	3.50-4.00	9	2.00-3.00	10	....	....	80.00	50.00	Increased rates	No
Richmond	P	3.50	10	1.75-2.00	10	.20-.06½g	.20-.05¾g	....	....	Increased rates	No
Rising Sun	P	4.00	10	2.00	10	.35g	.25g	190.00	130.00	Drawing on surplus & debt	Yes
Rockport	P	2.75	9	2.00	9	.30g	.25g	.283	.18+	Increased rates	....
Rushville	M	3.50	10	2.50	10	2.00f; .20g	1.85f, .18g	....	....	Drawing on surplus	No
Seymour	P	3.00-3.50	10	1.50-2.50	10	.30-.08g	.40-.12g	....	....	.....	....
Shelbyville	P	.30	10	....	..	.30g	.30g	5.62 per 1,000	....	.....	....
Tell City	M	2.00	9	1.50	10	.30g	.20g	9.25	5.75	City treasury	No
Terre Haute	P	3.50-4.50	10	2.00-2.50	10	.35-.07g	.30-.04¼g	....	....	Increase in rates, cutting out div., reducing consumption	No
Wabash	P	.30	9	.20	10	.25-.05f	same	43.6 pumped	no record	Loans and surplus	No

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Iowa:											
Algona	M	5.00	10	3.00	10	$.40-.20g	$.40-.20g	$100.00	$95.00	Increase in rates	No
Atlantic	M	4.00	10	2.50	10	.30-.10g	.30-.10g	90.00	30.00	Bond issue and surplus	No
Boone	M	4.00	8	2.25	9	.50-.08¼f	.35-.12g	150.00	150.00	....	No
Burlington	P	.50-.40	9-8	.20	8-9	.30-.12½g	.25-.12½g	58.39	38.20	Increased rates	No
Cedar Falls	M	.40-.50	8-9	2.50	10	.22½-.05f	same	59.50	42.50	Drawing on surplus	No
Cherokee	M	.35	10	.25	10	$1.87 per m f; 25g	same	....	....	Tax levy, revenue from plant	No
Colfax	M	.50	8	....	8	....	.30-.10g	....	....	Rates support expense	No
Eagle Grove	M	.40	10	.30	10	.30-.09f	same	....	....	Cutting force	No
Ft. Madison	P	4.80	8	1.50	9	.60 down g	.40 down g	....	....	Raise in rates	No
Iowa Falls	M	4.00-5.00	8	2.00-2.50	10	.40-.20g	.35-.15g	....	....	Increased consumption & rate	No
Knoxville	..	3.60	9	2.50	10	.45f; .60g	.30f; .40g	112.00	81.00	Cutting force—meters	No
Maquoketa	M	4.00	10	2.50	10	.16 2-3-.10g	same	45.00	40.00	From surplus & new services	No
Marshalltown	M	.40	8	2.50-2.75	8	.40-.07½g	same	66.00	45.00	Cut in extension work	No
Mt. Pleasant	M	.40	9	.20	9	.50-.20g	.50-.20g	....	....	From city treasury, drawing on surplus and cutting force	No
Muscatine	M	4.00	9	3.00	9	.25f	.25f	50.00	34.00	Drawing on surplus	No
Osceola	M	.30	..	.25	..	.75g	.50g	....	....	Raised water rates	No
Ottumna	M	4.00	8	2.00	8	.25-.06½g	same	51.75	25.00	By development of water power and sale of surplus power	No
Sioux City	M	.45	8	.60	8	.25-.10g	same	69.11	42.66	20% service charge	No
Washington	M	.55	9	.25	10	.30f, .40g	.30f. .40g	....	....	Bonds	No
Kansas:											
Atchison	P	3.60	8	2.00	8	.35-.09g	.30-.10g	12.00	7.00	Increase in rates	Slightly
Cherryvale	M	3.50	8	2.50	8	.50g	same	12.00	8.00	Cutting down force	No
Council Grove	M	3.00-3.50	8	2.50	8	.30g	.30g	116.00	80.00	Funds from city treasury	No
Emporia	M	3.20	8	1.75	8	.30-.06½g	.25-.05g	....	....	....	No
Ft. Scott	M	4.00	8	2.00	8	.27½-.065f	.27½-.25g	80.00	50.00	Better collections and management, cutting fuel cost	No
Fredonia	M	3.20	8	1.60	8	.10-.25g	same	....	....	....	No
Great Bend	P	3.20	8	2.50	10	.30g	.30g	100%	200%	Poorer service and maintenance	Yes
Herington	M	3.20	8	2.40	8	.20-.40g	.10-.20g	....	....	By electric end of revenue	Yes
Hiawatha	M	3.20	8	2.40	8	.40g	.40g	45.00	50.00	Funds from city treasury	No
Holton	M	3.20	8	2.00	8	1.00-.15g	.60-.30g	.20	.16	....	....
Humboldt	..	.40	8	.35	8	.35g	.25g	.18	.08	Additional levy	No
Hutchinson	P	3.20	8	2.00	10	.20½ av. g	.18 av. g	112.50	88.20	Deferring maintenance & drawing from surplus	Yes
McPherson	M	.40	8	.30	8	.25g	.25g	....	....	....	No
Manhattan	M	4.00	8	2.00	8	.15f, .20g	same	....	....	Bond issue & drawing on surpl.	No
Newton	M	3.00-5.00	8	2.00	8	.25-.11f	.25-.15g	....	....	Minimum of improvements	No
Osage City	M	3.20	8	2.00	8	.40g	.30g	....	....	Raised rates	No
Osawatomie	M	.50	8	.30	8	.35-.12g	.30-.06g	....	....	....	....
Pittsburgh	..	4.50	8	2.50	10	.25-.10% dis. g	.50-20% dis. g	112.10	80.00	....	No
Topeka	M	3.75	8	2.75	8	....	....	14.31	9.6	Reducing force, cutting exten.	Yes
Kentucky:											
Catlettsburg	P	4.50	10	1.25	10	.35-.09g	.25-.08g	....	....	Cutting force & drawing on sur.	....
Covington	M	4.00	8	3.00	9	.18f	.14f	.12½	.8	....	Yes
Hopkinsville	P	.30	9	.15	10	.36-.15g	.30-.10g	151.	140.	Increase of floating debt	No
Mayfield	M	.30	9	.15	10	.40g	.30g	15.00	9.00	Reducing consumption and increasing rates	No
Nicholasville	M	2.50	8	1.50	9	.35g	.30g	....	....	Drawing on surplus	Yes
Paris	P	2.50	10	2.00	8	.25g	.25g	....	....	....	Yes
Providence	M	4.00	9	2.00	10	.30-.13g	same f	120.	50.	Increased business	No
Richmond	P	3.00	9	5.00	8	.27½f	.27½f	....	....	....	....
Louisiana:											
Baton Rouge	P	2.50	9	1.25	9	.26f, .35-.10g	same	....	....	Adding pipe line to take additional territory	No
Kentwood	M	2.00	10	1.50	10	....	....	....	....	Funds from treasury	No
Maine:											
Bath	M	4.00	9	1.50	9	.30f	.25f	....	....	Increase in rates	No
Caribou	P	3.50-4.00	9	2.00-2.25	10	.07½f, .10g	same	11.00	8.00	....	No
Ellsworth	P	3.25	9	1.75	9	.40-.10f	no meters	....	....	Increase in rates	No
Gardiner ... Water Dist.		3.50	9	2.00	9	.20f	.20f	....	....	Drawing on surplus	No

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Maine (continued:)											
Norway	P	4.00	8	2.50	9	$.20-.25g	same	....	....	.....	No
Rumford	M	3.60	9	2.70	9	.22½f, 2.25g	$.30f, 3.00g	....	....	No increase	No
Sanford	P	3.25-3.50	9	1.85	9	.25g	.25g	....	....	From surplus	No
So. Paris	M	3.50	9	2.00	9	....	....	....	....	.....	No
Van Buren ..	Water Dist.	3.25	8	2.50	10	....	....	....	....	Fewer extensions and strict economy	No
Massachusetts:											
Adams	M	4.00	..	2.50	8	.10g	.10g	....	....	Drawing on surplus	No
Amesbury	..	4.00	8	2.50	9	.18¾-.37½f	same	....	....	.....	No
Belmont	M	4.00	8	2.50	8	.20-.15f	same	$62.10	$60.05	Earnings of dept.	No
Brockton	M	.68	..	2.50	8	.19-.10f	.17-.10f	101.54	58.74	Bond issues, increase in rates	No
Cambridge	..	4.00-4.25	9	2.50-3.00	9	.18½f, .25g	same	97.00	86.00	Surplus earnings	No
Cherry Valley and Rockdale	dist.	3.60	8	1.75	9	....	....	....	....	Increased rates	No
Concord	M	3.40	8	2.00	8	.20-.07½f	same	66.33	44.90	Cutting force and increase hydrant rental	No
Danvers	M	4.00	8	....	..	.13-.25g	.06½-.20g	10.36	16.00	.....	No
Fall River	M	4.20	8	2.25-2.40	8	.24-.10½f	.21-.07½	....	....	.....	....
Falmouth	M	4.00	8	3.00	8	.25g	same	....	....	Incr. in no. of water takers	No
Fitchburg	M	5.04	8	2.00	8	.18f	.18f	....	....	Reducing work	Yes
Framingham	M	4.40	8	2.50	8	.25 & slid. scale f	same	97.35	60.01	Increase in consumption and use of surplus	No
Haverhill	M	4.75	8	2.00	8	.07½-.10 less 15% f	same less 25%f	40.68	18.62	Increased rates	No
Lee	P	3.20	8	1.75	9	....	....	....	....	.....	Slightly
Leominster	M	4.40	8	2.00	8	.14f	.19f	....	....	Funds from city treasury and cutting force	No
Maynard	M	4.00	8	2.00	8	.37½-.10f	.37½-.10f	....	....	.....	No
Natick	M	5.00	8	2.25	8	.25f	.25g	34.68	20.45	Bond issue, increased water rates	No
New Bedford	M	4.75	8	....	..	.10-.15g	same	68.58	66.89	Increased consumption	No
North Adams	M	5.00	8	1.75	8	.05-.11f	.10-.15g	....	....	Increased appropriation	No
Oxford	..	.40	10	.25	10	.50g	.40g	....	....	Increased rates	No
Reading	M	4.00	8	2.50	8	.35-.15f	.23-.12f	....	....	.....	No
Somerville	M	4.00	8	2.15-2.25	8	.12f, .16g	same	....	....	.....	No
So. Hadley Falls	M	4.00	8	3.00	9	.15-.10g	.15-.10g	....	....	Cut down on improvements	No
Springfield	M	.50	8	.28½	8	.22-.05f	same	212.500	137.000	Current rev. and deferred work	No
Walpole	M	4.00	8	3.00-3.25	8	22½f, .30g	.22½f. .30g	19.75	13.80	Increased rates	No
Williamstown	P	3.50	8	2.00	8	.27-.06f	.22-.04f	....	....	Increase in rates	....
Worcester	M	.50-.62	8	....	8	.20-.10g	.20-.10g	68.81	101.68	Increase in business	No
Michigan:											
Battle Creek	M	5.40	9	2.50	10	.04-.13g	same	43.00	38.50	Drawing on surplus	No
Big Rapids	M	3.50	10	2.50	10	.08g	same	4.00	same	.....	No
Coldwater	M	3.50	10	1.50	10	....	....	....	....	Raising rates, inc. consumption	No
Crystal Falls	M	4.23	9	2.25	9	.10-.03f	same	....	....	Drawing on surplus	No
Highland Park ..	M	4.00	8	2.50	10	.07f, .09½g	.05.23f, .07g	56.40	52.36	Inc. consumption., inc. revenue	....
Holland	M	3.60-4.95	9	1.80-2.25	9	.09-3.6f	same	0.0930	0.0583	Drawing on surplus	....
Houghton	M	3.60	9	2.25	9	.12 & 100 per quarter service charge	.25f	73.50	75.22	.....	No
Iron Mountain ..	P	.45	8	.25	8	.22½-.06f, .30-.08g	same	13.00	13.00	Running behind	No
Jackson	M	3.60	8	....	..	.10f	.750f	20.86	....	Increase in rates	No
Ludington	M	4.00-5.00	8	.30	10	.10f	.10g	5.5	4.5	Raise in rate, curtailing new work	No
Mt. Clemens	M	5.00	9	3.00	9	.13-.08f	.11-.06f	66.02	29.70	.....	....
Niles	M	.50	9	.25	10	1.50-6.3f	....	....	....	Careful management	No
St. Joseph	M	.40	9	.35	9	.35-.20g	.15-.08g	26.00	12.00	Increased rates	No
Sault Ste. Marie.	M	3.00	8	2.25	8	.09-.05f	.15-.05g	....	....	Bond issue	No
South Haven	M	4.50	9	.30	9	.16f, .22g	.133f, .18g(j)	8.35	8.41(j)	.....	No
Minnesota:											
Bemidji	P	.35	8-10	.40	8-10	.30-.20f	same	.05-1000g	same	.....	....
Cloquet	M	5.00	10	2.50	10	.09-.50g	same	86.00	....	.....	....
Crookston	P	.40	10	.25	10	.45-.08g	....	....	....	.....	....
Fairmont	M	3.50-4.00	10	2.00-2.50	10	.25-.05f	same	....	....	.....	....
Lake City	M	.35	10	.22½	10	.12½f, 12½g	same	14.80	10.20	By 100% metering	No
Little Falls	P	3.50	10	....	..	.30-.25g	same	....	....	.....	....
Northfield	M	4.00	10	2.50-3.00	10	.15f	.15f	40.29	36.40	Drawing on surplus, cutting expenses	No

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Minnesota (continued):											
Rochester	M	.55	8	2.50	10	$.30f	$.25f	$75.00	$54.00	Increase in rates & consumption	No
Two Harbors	M	.65	8	.28	9	.07g	.04¾g	27.00	15.00	Increase in rates	No
Wabasha	M	3.50	10	2.00	10	.15g	....	50.00	....	.....	....
Willmar	M	.40	9	.35	9	.35-.06f	same	....	....	By increasing output	No
Mississippi:											
Bay St. Louis	P	2.50-3.00	8-9	1.50-2.00	9	....	....	....	....	.....	....
Canton	M	2.50	10	3.00	10	.20f	.20f	....	....	Metering & borrowing	No
Corinth	M	3.00	12	2.50	12	.18f, .60-.15g	....	....	....	Advance in rates	....
Jackson	M	2.00	9	1.25-1.50	10	.20-.10f	same	75.00	65.00	Pitometer survey, reducing forces, cutting expenses	Yes
Missouri:											
Aurora	P	.30	10-12	.20-.25	10-12	.25g	.25g	....	....	.....	....
Carrollton	P	4.00	8	2.00	10	.50-.15g	.40-.15g	....	....	By motor driving pumps and metering	No
Chillicothe	M	3.20	8	2.00	8	.40-.12g	.50-.20g	85.00	....	.....	No
Princeton	M	3.50	10	3.00	10	.40-.20g	.30-.20g	....	....	Cutting force and raising rates	Yes
Trenton	M	.40	8	.20	9	.40f	.30f	....	12.50	Increase in rates	No
Montana:											
Billings	M	5.00	8	3.00	8	.25-.05f	.25-.10f	22.92	11.20	.....	No
Bozeman	M	4.00	8	3.00	8	1 min. f-2.40g	....	54.70	....	.....	No
Deer Lodge	P	6.00	8	3.00	8	.08-.33g	.08-.33g	....	....	Drawing on surplus, loans	No
Glendive	M	4.50	10	3.00	10	.40f, .15g	$1 per mo.	200.00	150.00(h)	Cutting force	No
Kalispell	M	4.00	8	2.50	8	.50-.057f, .40-.07½g	same	39.25	36.59	Drawing on surplus, stopping waste	No
Missoula	P	4.50	8	3.00	8	....	....	....	....	Loss of net income	No
Nebraska:											
Aurora	M	.40	10	.25-.35	10	....	....	....	....	By economy	No
Crete	M	.50	..	.30	..	.20g	.20g	11.70	11.70	.....	....
Hastings	M	3.60	8	2.40	8	.18f	.14f	68.20	96.10	Increased rates	No
Nebraska City	P	3.60	8	2.00	8	.30g	.25g	99.75	52.50	By borrowing money	Yes
Schuyler	M	4.50	10	3.59	10	.20f, .26 2-3 g	.15f, .20g	195.81	....	Increasing rates & consumption	No
New Hampshire:											
Claremont	M	3.60	9	2.00	10	.15f, .20g	.15f, .20g	34.00	28.00	Gravity system	No
Dover	M	4.00	9	2.00	9	.23-.19f	.23-.15f	8.21	7.78	.....	No
Franklin	M	3.25	9	2.00	9	.37½f	.30f	106.00	74.00	Raised rates	No
Lebanon	M	3.50	9	2.00	9	.25-.12½g	same	....	....	.....	No
Newport	M	3.50	9	2.00	9	.25-.13½g	.25-.13½g	....	....	Making no extension	No
New Jersey:											
Bridgeton	M	3.00	9	1.50	9	....	....	29.30	24.07	.....	No
Cape May	M	.40	8	.35	9	.20g	same	....	....	.....	No
Essex Falls	M	4.50	9	2.25	9	.17-.30g	....	....	....	Changing from steam to fuel oil engine	No
Freehold	M	3.60	9	1.75	9	.15f	.15f	130.00	70.00	.....	No
Hawthorne	..	5.00	44 per week	1.25(j)	10	.20-.04f	same j	20.00	....	Bond issue	No
Jamesburg	P	4.50	9	2.75	9	.25g	.25g	....	....	.....	....
Newton	M	3.75	9	1.25	9	.25-.04g	same	....	....	Drawing on surplus, cutting force	No
Nutley	M	3.60	8	2.50	8	.30f	.375f	364.00	....	Decreasing unaccounted for water	No
South River	M	.45	8	.15	10	.25g	.25g	234.00	377.00	Increase in revenue	Yes
Wallington	M	.50	8	1.75	10	.20f	same	....	....	.....	....
New Mexico:											
Tucumcari	M	.50	8	.30	11	.50f	.35f	150.00	120.00	.....	....
New York:											
Carthage	M	4.50	9	2.00	9	.36-.06f	.36-.06f	....	....	.....	....
Cortland	M	3.20	8	1.75	8	.15f	.15f	45.00	30.00	Revenue from sale of water	No
Dansville	M	2.75	9	1.75	10	.12g	.12g	.0052	.004	Cutting force & drawing on surpl.	No
Elmira	M	4.00	8	2.40	8	.30-.06f	same	43.10	27.00	Increasing earnings	No
Glens Falls	M	3.00	8	1.50	8	....	....	37.60	54.06	.....	No
Gloversville	M	.50	48-50 week	.70	..	.12-.03½f	....	....	....	.....	No
Homer	M	.40	10	.30	10	.40g	.30g	....	....	By tax	No

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
New York (continued):											
Hudson	M	3.00	8	1.50-1.75	8	$.05g	$.05g	$25.00	$12.50	Bond issue	No
Jamestown	M	3.20	8	2.00	8	.20f	.15f	39.13	61.46	.....	No
Little Falls	M	3.60	8	2.00	8	....	....	30.00	not metered	Refunding bonds	Yes
Lowville	..	2.50	10	4.00	10	.20f	.20f	3,500 year	....	.....	No
Medina	M	2.80	8	2.00	10	.40-.12g	same	....	....	.....	No
Mt. Morris	M	.35	8	.30	9	.40-.20g	....	13.61	....	.....	No
Mt. Vernon	P	4.50	8	.17½-.20	9	.30-.12f	.30-.10f	....	....	Drawing on surplus	No
Ossining	M	4.00	8	2.50	8	2.00f	1.50f	....	....	Raised rate	No
Peekskill	M	3.30	8	1.75	8	.20f	.10f	80.00	30.00	Loan	No
Salamanca	..	3.00	8	1.75	8	....	....	....	....	Less surplus	No
Scotia	M	.40-.45	8	.25	8	.30f	.20f	72.00	72x20%	Increase in rate	No
Seneca Falls	P	3.60	9	1.50	9	.20-.10f, 26½-.13¼g	same	22.00	50.00	Deferring interest payments	No
Waverly	M	3.60	9	2.00	9	.30-.06f	same	....	....	Out of earnings	No
Wellsville	M	3.50	8	1.50-1.75	9-10	.225 net f	.27 net g	82.00	44.00	Incr. in rates & drawing on sur.	Somewhat
North Carolina:											
Charlotte	M	2.50	10	1.25	10	.17 1-3f, .23g	.25f, .33 1-3g	140.00	123.00	.....	No
Durham	M	2.50	10	1.50	10	.25g	.25g	.13+	....	.....	....
Goldsboro	M	2.00-2.50	10	1.50	10	.33 1-3-.0843g	same	....	....	By reduction of earnings	No
Henderson	P	4.00	10	1.25	10	.30-.18f	.26-.15f	120.00	80.00	Reducing consumption & waste	No
Kinston	M	2.00	10	1.00	10	.30g	.30g	300.00	190.00	Cutting force & drawing on sur.	Yes
New Bern	M	2.00	10	3.50	10	.25-.08g	same	110.00	130.00	From revenue of wtr. & lt. plnt.	No
Rocky Mount	M	2.00	10	1.50	10	3.00-.20f	2.00-.06f	90.00	60.00	.....	No
Wilmington	M	3.00	10	1.50	10	.16-.096f	....	....	....	City treas. & reducing consumptn.	Yes
North Dakota:											
Enderlin	M	4.50	10	3.00	10	.35g	.35g	200.00	200.00	.....	No
Valley City	M	4.00	10	3.00	10	.35f	.30f	115.97	142.63	Increase in output	No
Wahpeton	M	100 per mo.	8	90 per mo.	12	.23g	.23g	75.00	60.00	Reducing net earnings	No
Ohio:											
Archbold	M	4.00	10	3.00	10	.35g	.30g	....	....	.....	....
Barnesville	M	3.00	8	2.00	8	.50-.75g	.30-.40g	15.00	7.50	Increased rates	No
Bellevue	M	.45	8	.20	10	.30-.05g	same	51.40	39.40	Drawing on surplus	No
Cleveland	M	.60	8	.25	8	.06f, .08g	.04f, .05¼g	46.67	34.15	Bond issue & drawing on surpl.	No
Conneaut	P	4.50	8	3.50	9	.25-.06g	.25-.06g	....	....	.....	....
Dayton	M	.40-.42	8	.25	8	.12-.06f, .90-.45g	.08-.06f, .60-.45g	75.00	46.75	Decreasing force	No
Delaware	P	4.00	10	2.50	10	.30f	.25g	....	....	Borrowing money	No
East Liverpool	M	4.00	8	2.00	8	.66 2-3-.10g	.40-.08f	....	....	Increasing rates	No
East Youngstown	..	4.00	8	4.00	10	.25g	.25g	25.00	17.50	Increased consumption	No
Eaton	M	.40	10	.25	10	.37½g	.23g	....	....	Bond issue & increase in rates	No
Franklin	M	4.00	8	3.00	10	.10-.18g	.07-.15g	....	....	Raising rate	No
Gibsonburg	M	.40	..	.50	10	.35-.25f	....	....	....	Bonds for extension	No
Hidesville	M	4.00	10	1.50-2.00	10	.40g	.25g	....	....	Raising rates	No
Hillsboro	M	4.00	10	2.50	10	1.15-.45g	.90-.35g	....	....	Surplus	....
Lakewood	M	.50	8½-10	.25	8½	.12f	.10f	....	....	Increasing rates, reducing leaks, drawing on surplus	No
Logan	M	3.20	8	2.00	8	.40g	.20g	....	....	Raising water rents	No
Marietta	M	3.20	8	2.00	9	.12-.30g	.06-.30g	....	....	Increasing water rents	No
Martins Ferry	M	3.50	8	3.00	8	.25 domestic .02½-.10 industrial	same	37.90	36.40	Revenue adequate	No
Medina Village	M	.40	8	.35	9	....	½ of present rate	....	1-3 less than present	Advance in rates	No
Middletown	M	.50	8	.25	9	1.25 per 1,000 cu. ft. quarterly	1.00	92.00	....	Bond issue & cutting consumption	No
Napoleon	M	.35	8	.25	10	.25-.10f	.15-.08f	....	....	Raising rates	No
Newark	M	3.60	8	....	..	.18f	.15f	....	....	.....	No
Niles	M	5.20	8	2.00	8	.04½f	.04½f	35.00	32.00	Water rents	No
Ottawa	M	.40	8	.20	10	1.00f	.10g	200.00	38.00	Funds city treasury	....
Ravenna City	M	.50	8	.25	10	....	....	61.53	25.50	Metering, tax	No
Reading	M	4.00	8	2.50	8	.10-.40f	.06-.20f	....	....	Used surplus & raised rates	Yes
St. Marys	M	.38	8	.25	8	.25f	.15f	600.00	....	Raising rate	No
Springfield	M	.50	8	.17½-.22½	8	.07½-.04½f, .06-.10g	same	29.00	21.40	Drawing on surplus	Yes
Toledo	M	.55-.70	8	.27½-.35	8	.10f	.0675f	58.55	25.20	From water revenues	No
Urbana	M	3.50	..	1.75-2.00	..	.25g	.25g	....	....	Reducing or cutting out new work	No

METER RATES—FINANCES—LABOR—(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Ohio (continued):											
Van Wert	M	.45	8	.30	8	$.265f	$.1875f	$80.00	$72.00	Increase in rates	No
Wapakoneta	M	4.00	8	3.00	8	.25-.08f	.20-.04½f	....	....	Drawing on surplus	No
Wilmington	P	4.00	10	2.50	10	.25g	.25g	225.00	200.00	elec. motor driven instead of stm.	No
Oklahoma:											
Altus	M	4.00	8	1.50	8	.25-.17½g	same	....	....	Funds from other depts.	Yes
Hugo	M	3.00	8	2.00	8	.12-.35g	.06-.35f	50.00	35.00	Increasing rates	No
Sapulpa	M	4.50	8	2.40	12	.45g	.25g	....	....	Higher rate	Yes
Tahlequah	M	3.20	8	1.50	10	.50g	....	....	....	Funds from treasury, reducing consumption	Yes
Oregon:											
Hood River	M	4.00	8	2.50	9	.33-.11g	same	....	....	Drawing on surplus	No
Marshfield and North Bend	P	3.60	8	2.50	8	....	....	....	....	Increased volume of business	....
Roseburg City	P	3.50	8	....	..	....	....	....	....	.....	Yes
West Linn	M	4.00	8	2.50	8	.15g	.15g	4.00	2.50	From water receipts	No
Pennsylvania:											
Berwick	P	.40	9	.15	10	.08-.35g	same f	....	....	Keeping expenses down	No
Catasauqua	M	3.00	10	2.00	10	.04-.25f	same	....	....	.....	No
Chambersburg	M	.30-.40	10	.175-.185	10	.10f	.10-5% off f	.....	....	Gravity supply, only 2 men	No
Duquesne	M	.50	10	.38	10	.35g	.25g	325.00	300.00	Raise in water rents	No
Erie	M	2.50-3.50	10	1.75-2.00	10	.20g	same	32.742	12.89	.....	No
Hamburg	P	4.00	10	2.00	10	.30 down f	same	....	....	Increased consumption	No
Hollidaysburg	..	.40	..	.20	..	....	....	....	....	Gravity plant	....
Jersey Shore	P	3.15	9	2.00	10	.25g	.25g	....	....	Increasing rate	No
Lancaster	M	.42	9	.35	9	.05g	same	.061⅓	.05	City treasury & reduction in force	No
Lebanon	M	.30	10	.20	10	....	....	30.00	16.00	Surplus	No
Lehighton	P	.40	10	.15	10	.50-.08g	.25-.03g	....	....	Drawing on surplus, cutting force	No
Lewiston	..	4.00	10	1.75	10	.40-.035f	.33 1-3-.03f	....	....	Increased revenues	No
McDonald	P	3.00	9	2.00-2.25	9	.35g & $3a quarter, service, charge	.60-.10g	.16	.09	Surplus—increase in rate	Yes
Media	M	.35	9	1.50	9	.20-.10g	.10-.07g	91.82	60.49	Increase in rates	....
Meversdale	P	3.50	9	2.00	9	.30g	.30g	....	....	Drawing on surplus, cutting force	No
Minersville	P	4.00	8	1.75	9	.20-.06f	same	....	....	No extensions or renewals	Yes
Nazareth, Pen Argyl, Wind Gap	P	.40	..	.20	..	.06-.20f	.05-.15f	....	....	Cutting down force	No
Rankin	M	5.40	10	2.00	10	.17f	.17f	135.00	130.00	Funds from boro treasury	No
Shamokin	P	4.20	8	1.62	..	.20-.04f	same	....	....	Cutting force, curtailing repairs, improvements, etc.	Yes
Sharpsville	M	3.70	8	2.62	8	.30g	.20g	12,000 total	6,000	Boro general fund	No
Stroudsburg	..	.30	10	.20	10	.10f	.10f	....	....	.....	No
Susquehanna, Lanesboro	P	4.50	9	2.70	9	.40-.25g	same	....	....	Careful economy	....
Tyrone	P	4.50	9	1.75	10	.10-.02g	same	16,000 total	5,500	Drawing on surplus	No
Uniontown	..	.40	9	.175	10	.25g	.25g	....	....	From surplus	No
Wilkinsburg	P	3.78-5.00	9	1.75-2.25	10	.20f	.20f	....	....	Increased consumption	No
South Carolina:											
Aiken	M	1.50	10	1.00	10	.50g	.30g	....	....	Cutting pay & raising rates	No
Charleston	M	2.00-3.50	10	1.50-2.00	10	.185-.045f, .246g	same	76.40	....	From surplus	No
Cheraw	M	1.50	10	1.50	10	.37-.15g	.33 1-3-.10g	100.00	75.00	Increased rates	No
Clinton	M	2.00	10	1.00	10	.40-.10g	.30-.10g	....	....	Increased rates	No
Darlington	P	1.50	10	....	..	.30g	.30g	....	....	.....	No
Easley	M	2.00	10	.90-1.10	10	.10-.25g	.10-.25g	....	....	Earnings from plant	No
South Dakota:											
Rapid City	M	5.00	9	3.00	9	3.00 1st 1200f, rest .07½	same	5.00	4.00	Curtailing extension	Somewhat
Tennessee:											
Clarksville	M	2.50	10	1.25	10	....	20% less than pres.	10.00	6.50	Raising rates	No
Dyersburg	M	2.50	10	1.50	10	.30g	.15g	30.00	90.00	From treas. & reduced consumptn.	No
Union City	M	2.00	10	1.75	10	....	....	....	....	Raised rates	No

METER RATES—FINANCES—LABOR —(Continued)

City and state	Private or municipal	Present wages of common labor	Hours per day	Wages of common labor in 1914	Hours per day	Present meter rates: f-per 100 cu.ft.; g-per 1,000 gals.*	Meter rates* in 1914	Operating costs in 1920 per 1,000,000 gals. of water delivered	Operating costs in 1914	Method of meeting increased costs of last three years	Has plant lapsed in condition or capacity because of finances
Texas:											
Brownsville	M	1.50-1.75	8	1.50-1.75	10	$.30-.15g	same	....	....	From treas. & neglected impvts.	Yes
Dallas	M	3.50	8	2.20	8	.25-.15g	same	$.14	....	Overdraft	No
Galveston	M	110 monthly	8	95 monthly	8	.20f	$.20f	78.98	$93.75	.....	Yes
Hillsboro	M	3.50	8	1.75-2.00	8	.50g	.25g	300.00	180.00	Funds from city treas., over draft	....
McKinney	M	2.50	8	1.75	8	.40-.35g	same	270.00	200.00	Drawing on surplus	Yes
Stamford	P	.40	8-10	.15-.175	8-10	.15-.50f	same	....	....	.....	....
Vermont:											
Fair Haven	M	.50	9	.25	9	1.875f, .25g	same	....	....	Increase in flat rate	....
Northfield	M	3.00	9	4.00	8	.25f	.28f	....	....	By revenue	No
Richford	M	.30	9	.30	10	....	....	....	....	Drawing on surplus	No
Virginia:											
Covington	M	2.97	9	1.50	10	.10g	.10-.05g	....	....	Funds from treasury and cutting down force	No
Martinsville	M	2.50	10	2.00	10	.15 plus 10%g	.15g	44.00	40.00	Funds from city treasury	No
Richmond	M	4.00	9	2.25	9	.09-.06f	.11-.375f	4.50	3.35	From general appropriation	No
Washington:											
Anacortes	..	3.20	8	2.25-2.50	10	....	....	....	....	.....	....
Bellingham	M	.50	8	.50	8	1.00 min. for 400 ft.	100 for 300 ft.	....	....	Economy	No
Dayton	M	3.50	8	3.00	8	1.00-.10g	same	....	....	.....	....
Hoquiam	P	4.40	8	2.50	9	.375-.06f	.30-.05f	....	....	.....	No
Palouse	M	3.50	8	2.40	8	1.25-.25g	1.00g	....	....	Funds from treas., & cutting force	Yes
Pullman	M	4.00	8	2.50	8	1.00-.10g	1.00-.20g	1,300 total	1,300	.....	No
Seattle	M	4.75-5.25	8	3.00	8	.08g	same	59.40	66.985	Increased revenue & greater efficiency	Yes
Spokane	M	5.00	8	3.00	8	.10g	.10g	2.05	1.58	Cutting force & reducing waste	Yes
Walla Walla.....	M	4.00	8	2.50	8	.75-.08g	same	....	....	.....	No
Winlock	P	3.20	8	2.50	9	.40g	.30g	....	....	Cutting force & extensions	Yes
West Virginia:											
Princeton	P	4.00	10	2.50	10	.50g	.40g	....	....	Drawing on surplus	Yes
Wisconsin:											
Antigo	M	3.00-4.00	10	1.75-2.50	10	.35 max. f	same	....	....	Using surplus	No
Ashland	P	4.00-5.00	10	2.00-2.25	10	.18f	.12f	.065	.049	Increasing floating debt	No
Baraboo	M	3.00	10	2.25	10	.15g	.15g	70.00	60.00	.....	No
Fond du Lac ...	M	4.50	9	2.75	10	.30f..40g	same	....	....	Drawing on surplus	No
Green Bay	M	.50-.55	9	.175-2.25	10	.24-.05f	.22-.14	....	....	.....	No
Jefferson	..	.40	10	.25	10	.12f, .16g	same	125.00	191.00	Efficiency in operation	No
La Crosse	M	.45	8	.25	9	.15-.03f	.15-.030f	38.43	21.17	Increased budget & 5% surcharge	No
Madison	M	.40	9	.25	9	.075f	.06f	45.00	37.60	Increased efficiency	No
Milwaukee	M	.50-.70	8	.25-.31¼	8	.07f, .09 1-3g	.04½f-.06g	24.59	15.87	From water rates	....
New London	M	.40	10	.35	10	.20-.12g	.15g	140.00	190.00	Increased consumption and rates	....
Platteville	M	3.00-4.00	10	2.00-3.00	10	.30-.10g	.30-.10g	242.32	235.76	City levy in taxes	No
Stevens Point ...	P	3.50	8-9	2.00	8-9	.26-.03⅜f	same	61.00	28.00	.....	....
Watertown	M	.40	10	.25	10	.16-.04¼f	same	....	....	Increased consumption	No
Wyoming:											
Cheyenne	M	4.00	8	5.00	8	.25-.05g	same	....	....	Funds from city treasury	....
Green River and Rock Springs..	P	.485	8	.25	10	1.50-.40g, 1.12-.30f	....	218.00	116.00	Reduced returns on investment	No
Canada:											
Manitoba	M	.60	8	.25	9	.23f	.23f	199.83	238.75	Economy & efficiency	No

*Where rates are on a sliding scale, the highest and lowest are tabulated when reported.

a—For electricity. b—Buy water at 16 cents per miner's inch, sell it at flat rate $1.25 to $5.00 per month. c—Includes operation, distribution, office, fixed charges, taxes, etc. d—Distributing system municipal. e—For year ending Sept. 1. f—Not including interest or depreciation. g—Needed new supply main and increased storage not built. h—1916. j—1915.

NEWS OF THE SOCIETIES

June 6—COUNCIL ON STANDARDIZATION. Hollenden Hotel, Cleveland.

June 6-10—AMERICAN WATER WORKS ASSOCIATION. Annual convention, Hollenden Hotel, Cleveland. Secretary, J. M. Diven, 153 W. 71st st., New York City.

June 7-10—KENTUCKY STATE ROAD ENGINEERS. Annual convention. Armory, Louisville, Kentucky.

June 10—ROCHESTER ENGINEERING SOCIETY. Annual meeting. Election of officers. Rochester Engineering Society Rooms

June 13—AMERICAN FEDERATION OF LABOR. Albany Hotel, Denver, Colo.

June 13-14—CLEVELAND SECTION AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Regional meeting Great Lakes Territory. Hotel Statler.

June 14-16—NATIONAL FIRE PROTECTION ASSOCIATION. Annual meeting. San Francisco.

June 15-17—LEAGUE OF MICHIGAN MUNICIPALITIES. Annual Convention. Kalamazoo, Mich.

June 17—PHILADELPHIA SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Outing at Howard McCall Field.

June 17—INLAND EMPIRE SECTION. AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Joint meeting with engineering societies of Spokane.

June 20—AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Salt Lake City.

June 20-24—AMERICAN INSTITUTE OF CHEMICAL ENGINEERS. 13th semi-annual meeting. Detroit, Mich.

June 20-24—AMERICAN SOCIETY FOR TESTING MATERIALS. Annual meeting. Asbury Park, N. J.

June 28—ATLANTA SECTION, AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Election of officers. Georgia School of Technology, Atlanta.

June 28-July 1—SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, UNIVERSITY OF PITTSBURG. Annual convention. New Haven Conn

July 15—NEW ENGLAND ASSOCIATION OF COMMERCIAL ENGINEERS. Annual meeting. Crown Hotel, Providence, R. I.

Aug. 10-12—INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS. Annual conference. Hotel La Salle, Chicago, Ill

Sept. 28 (10 days)—NEW YORK ELECTRICAL EXPOSITION. Seventy-first Regiment Armory, New York City.

Oct. 11-14—INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS. Annual Convention, Atlanta, Ga. Hotel Ansley. Secretary, James J. Mulcahey, Municipal Building, Denver, Colo.

Oct. 24-28—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention. Southern Hotel, Baltimore, Md. Secretary, Charles Carroll Brown, Valparaiso, Ind.

Nov. 14-18—AMERICAN PUBLIC HEALTH ASSOCIATION. Annual meeting. New York City.

ROCHESTER ENGINEERING SOCIETY

At the annual meeting of the Rochester Section of the American Institute of Electrical Engineers in the Eastman building, University of Rochester, May 27, Dr. John R. Murlin, head of the Physiological Department, University of Rochester, gave a talk and demonstration on the uses of electricity in physiology and medicine. Dr. Henry D. Clough demonstrated the electro-Cardiograph.

COUNCIL ON STANDARDIZATION

The Council on Standardization, which was established at Montreal in 1920, will hold a meeting at 4 p. m., June 6, 1921, at The Hollenden, Cleveland, to which all interested in its work are invited. It is proposed, tentatively to work at present through a number of regular committees composed of specialists, who will report on important current developments in fifteen classified subjects that have been carefully selected, namely, 1, Standard Methods of Water Analyses; 2, Electrolysis; 3, Standard Form of Contract; 4, Standards for Satisfactory Drinking Water; 5, Practical Ranges in Load Factors for Purification Plants; 6, Colloidal Chemistry in Relation to Water Purification; 7, Trade Wastes in Relation to Water Supply; 8, Methods and Records of Water Waste Control; 9, Testing of Water Works Materials and Supplies; 10, Essential Data for Water Department Records and Reports; 11, Practical Standards of Rules and Regulations of Relations Between Water Works and Consumers; 12, Steps Towards Standardizing Stated Quantities for Slides in Meter Schedules; 13, Watershed Protection; 14 Pumping Station Betterments; 15, Standardization of services. George W. Fuller, Chairman; Frank A. Barbour, Edward Bartow, George A. Johnson, George C. Whipple.

NATIONAL CONFERENCE ON CITY PLANNING

The 13th national conference on City Planning was held on May 9-11 at Pittsburgh, and was attended by some 200 persons from outside places. Meetings were held jointly with the Civic Club and the Real Estate Board of Pittsburgh.

Zoning in general was discussed by Robert H. Whitten and Herbert S. Swan, and the proposed zoning ordinance for Pittsburgh was outlined by U. N. Arthur and J. M. Clark. Next James D. Hailman described the recommendation of his committee for major street plan, and A. S. Tuttle spoke on "The Enforcement of a Street Plan." County Planning was discussed and advocated by W. Donley. Another important matter considered was the Distribution of Population, which was discussed by J. R. Bibbins and H. M. Brinckerhoff, the latter dealing with the distribution of the homes of employees of the larger industries. There were also two papers on River Transportation, by Maior J. Franklin Bell and Kenneth C. Grant. Aerial Transportation was considered by John Ihlder, and Aerial Photography reported on by E. P. Goodrich and Herbert S. Swan. The meeting was closed by John Nolen, who advocated an official planning commission with adequate powers and responsibilities.

Lawson Purdy, of New York, was elected president; George B. Ford, vice-president, and Flavel Shurtleff, of Boston, was re-elected secretary.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

At the annual business meeting of the American Institute of Electrical Engineers, held in New York on May 20, the following officers were elected for the administrative year beginning August 1: President, William McClellan; vice-presidents, Walter A. Hall, N. W. Storer, William A. DelMar, C. G. Adsit, John C. Parker, F. W. Springer, H. W. Eales, Robert Sibley, O. B. Coldwell and F. R. Ewart; managers, A. G. Pierce, R. B. Williamson, Harlan A Pratt; treasurer, George A. Hamilton; and secretary, F. L. Hutchison.

DETROIT ENGINEERING SOCIETY

The Detroit Engineering Society held its last meeting of the season on May 20, when Mr. Galusha and Mr. Clarke, of Dwight P. Robinson Co., New York City, gave a talk on "A Mine Mouth Super-Power Station." The meeting was held jointly with the Detroit section of the American Society of Mechanical Engineers and the Detroit-Ann Arbor section of the American Institute of Electrical Engineers. The following officers were elected at a recent meeting of the society: President, M. W. Taber; first vice-president, J. R. McColl; second vice-president, A. L. Trout; and secretary-treasurer, O. H. Dawson.

CANADIAN GOOD ROADS CONVENTION

The eighth annual convention of the Canadian Good Roads Association was held on May 10-12 at Halifax, and was attended by nearly 200 delegates, representing eight of the nine provinces of Canada. The most important discussions centered around the subject of federal aid for highways, and a keen enthusiasm for better highways resulted in suggestions for amendment. Many valuable technical papers were presented, and an instructive exhibit of road making machinery added to the interest of the meeting.

AMERICAN SOCIETY OF SAFETY ENGINEERS

A meeting of the American Society of Safety Engineers was held May 27, at 8 p. m., in the Engineering Societies Building, 29 West 39th street, New York City. The topic was "Electrical Hazards and Their Safeguards." Papers were presented on "High Tension Electric Generation and Transmission," illustrated by lantern slides, by Messrs. C. O. Van Dannenberg and W. W. Samuels. On "Electrical Hazards—Terminal Equipment of the New York Central Railroad Entering New York City," by H. S. Balliet, and on "Small Motor Problems and Industrial Control," by L. E. Smith (this paper was illustrated by lantern slides).

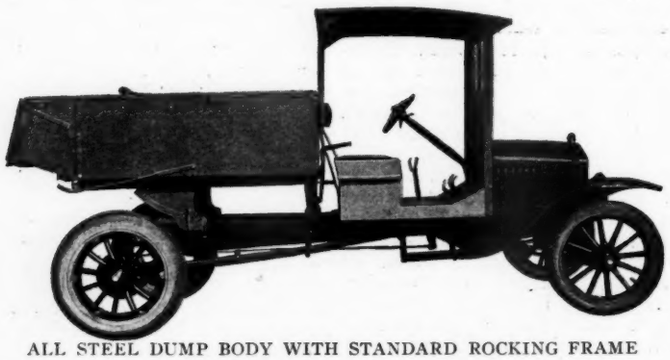
NEW YORK SECTION AMERICAN SOCIETY OF CIVIL ENGINEERS

At the annual meeting May 18 an address was made by Nelson P. Lewis on "What Does the New York Metropolitan District Mean?"

The following officers were elected: President, Nelson P. Lewis; secretary, J. P. J. Williams; directors, Charles Gilman and Joseph J. Yates.

New Appliances

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations



ALL STEEL DUMP BODY WITH STANDARD ROCKING FRAME

ANTHONY DUMPING EQUIPMENT

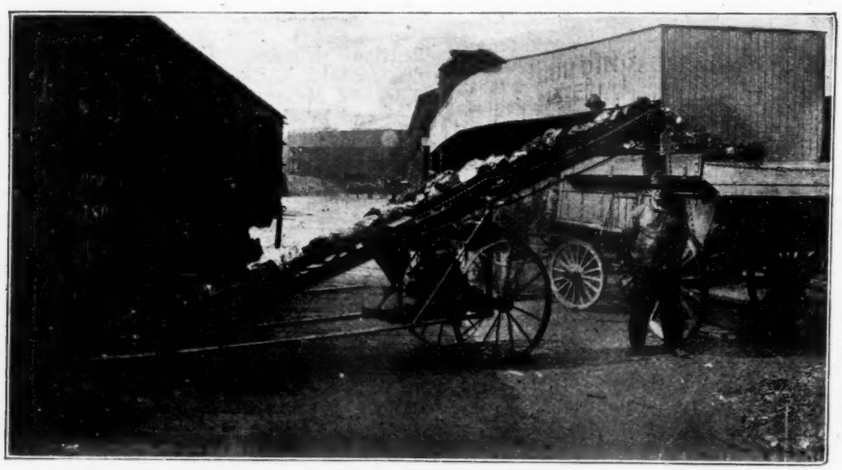
The dumping bodies manufactured by the Anthony Co. were first designed for, and appeared co-incident with, the Ford truck. They are now built in different styles for different construction and municipal services.

The All-steel body is supported near the center of gravity on elevated rockers operating near the rear end of the platform of a Ford truck chassis. The load is thus balanced, is easily and quickly dumped by the operation of a lever at the driver's seat. The standard rocking frame provides great interchangeability for all body types, there is no heavy machinery involved, and the large dumping angle insures instant and clean disposal of the load. The bodies are strong and light and can easily be arranged with an adjustable tail gate allowing them to discharge a load of crushed stone or other material continuously as the truck proceeds, so as to place a uniform thickness of top dressing for road construction. The bodies can also be provided with swinging partitions so that they can serve as batch boxes for loading the skips of concrete mixers with measured cement and aggregate for road and pavement work. A special type of box has been put on the market for handling garbage and is provided with a top cover that is raised and the tailgate opened when the body is elevated 50 degrees to the dumping angle.

THE BROWN PORT-A-BELT

The Brown Port-a-belt is made in 8 standard sizes, including two widths of belt to be used for loading and unloading cars and for loading wagons and trucks, reclaiming piles, delivering into bins and for similar purposes It is used mounted on a pair of wheels for convenient removal from place to place or suspended from overhead, and can be used singly or in series. The belts, which are 12 or 16 inches wide, are run at a speed of 200 feet per minute. They are equipped with either high, low or medium flights, according to the kind of material handled. They are made with lengths end to end of the belt, of 14 to 29½ feet, and maximum height of delivery of 6 to 15 feet. The motors of of 1½, 2 or 3 h. p., and the approximate weights of the machines with motors vary from 1,325 to 2,410 pounds. The belt is provided with sheet steel flaring side guards, increasing its capacity and is raised or lowered in 35 seconds by an enclosed worm gear operated by a crank.

CONVEYOR LOADING FROM STOCK PILE TO WAGON.



CONVEYOR LOADING FROM CAR TO WAGON

BLAW FORMS

Forms for every variety of concrete construction are made by the Blaw-Knox Company and described in catalog 23. All are made of steel and are collapsed mechanically.

Half round forms are interchangeable for arch and invert work and 75 linear feet are required for maintaining a uniform progress of 50 feet per day. Horseshoe forms are of two classes, made either telescopic or non-telescopic, for continuous or for alternate block construction. Full-round forms are manufactured in sections 5 feet long and made in sizes 36 inches to 144 inches in diameter. Each section is made in four or more pieces with joints in a horizontal plane, one of which is a wedge shape key. The forms are absolutely rigid and provide for perfect alignment.

Tunnel forms are made for railroad work where traffic is maintained and where traffic is not maintained, for waterway tunnels of horseshoe or circular shape and for miscellaneous tunnels. All railroad and horseshoe tunnel forms are provided with an integral traveling device and the form is collapsible but non-telescopic. When the form is telescopic a separate traveler is used.

Blaw-Knox tunnel liner plates take the place of wood siding, poling boards, segmental lining and built-up plates in soft ground work to support the natural arch of the ground while the permanent lining is placed. Blaw forms for subways are designed to suit the requirements for special occasions. The Blaw forms for heavy walls are cantilever and gantry type, some of which travel on integral frames. Heavy wall forms are designed to require few or no tie rods, thus promoting economy of construction. Special wall forms have been designed to eliminate cofferdam construction for subaqueous work. Forms for bridge piers are made with Blaw-Knox combination lagging which consist of 12 x 16-inch heavy reinforced plates with vertical liners and horizontal walers, so arranged that they can be fastened together permanently to form units of any size required.

Steel centering trusses are provided for concrete arches with clearance underneath for maintaining traffic and

for supporting the work over rivers and other places where falsework cannot readily be built.

Traveling floor forms are used on flat slab floors; beam and girder forms on groined arches may be made to allow for as much as 8 to 10 feet variation in height. Blaw forms are also designed for light walls and foundations and a complete system has been developed for concrete roads and highway and pavement construction for curbs and the like. The catalog us profusely illustrated with half-tone engravings of progress pictures showing the forms in service on important work.

SURFACING 30 MILES OF ROAD IN ONE DAY

DUPLEX HIGHWAY GRADING

In road maintenance it has been usual to frequently operate two-blade graders, tandem, hauled bv a tractor, dressing first one side of the road and then the other. Recently, however, an innovation has been reported from Park county, Wisconsin, where the outfit of Commissioner Moore, of Janesville, completed thirty miles of road maintenance per 10-hour day with a pair of Stockland quick lift graders with 8-foot blades, hauled side by side by a 10-ton Holt tractor.

The tongues of the graders were attached to the rear of the tractor, making equal angles with the axis of the road and the graders were operated in the usual manner by men mounted on them and controlling the hand wheels that shifted the blades as necessary. When the outfit crossed bridges too narrow for the graders to pass side by side, they were towed tandem, using the wire ropes shown in the background for tow lines. In order to finish the crown of the road after the graders had passed, and to leave a smooth, even surface from shoulder to shoulder, a small drag can be hauled behind the graders to cover the area between the blades of the machines.

LACKAWANNA SHEET PILES

Bulletin 109 of the Lackawanna Steel Co. is much more than an ordinary catalog; it is a well-conceived, admirably prepared and suitably executed monograph, covering the state of the art of steel sheet piling: showing the principal qualities and characteristics of interlocking steel piles, giving ample illustrations of the methods of handling and installing them, and of the structures made with them. Particularly of cofferdams, retaining walls and the like. It reflects great credit on the Steel Sheet Piling Department which produced it, and is of high value as a hand-book of sheeting and cofferdam construction, giving the principal features of important precedents, illustrated by numerous halftone and line engravings that, with the well-prepared descriptive text, give data of great value to engineers, superintendents and contractors and architects. It has 160 8 x 10½ pages, printed on heavy glazed paper with embossed stiff paper covers.

Among the numerous important works described where steel sheet piles were used are the Tunkhannok viaduct, the 46th Street pier, New York, the Blackrock shiplock, Buffalo, the cofferdam for the raising of the battleship *Maine*, installations for the New York State barge canal and for the United States government, besides a great number of bridge piers, foundations, retaining walls and other difficult and important structures. Devices for handling, assembling, driving, pulling and straightening, methods of driving and bracing, and many other practical features are very clearly presented.

The different sizes, weights, and styles of the Lackawanna steel sheet piles are listed and their essential features and uses are described, tables of their properties are given, concrete protected steel sheeting is described and illustrated and tests of the interlock are illustrated.

BARBER-BREEN SNOW LOADER

A circular issued by the Barber-Green Company, Aurora, Ill., describes the successful use of a portable electrically driven snow loader operated on the belt conveyor plan in Chicago with an efficiency of about 3 yards per minute. Photographs, diagrams, specifications are given.

AUTOMATIC LOWERING JACK

The Duff Manufacturing Co. is distributing its new bulletin, No. 308, which illustrates and describes their line of automatic lowering jacks. This type of jack, which is made in a wide variety of heights, is widely used by contractors for raising loads of any kind where a lifting capacity of 25 tons or less is required.

ROAD SUPPLY AND METAL CO.

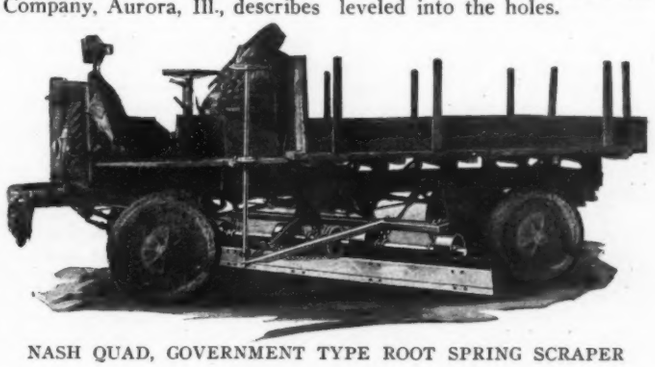
This company supplies wire bar-ties for connecting reinforcement steel rods together and also furnishes tying tools with which one man can make a tie in two seconds. By the use of the specially prepared ties which have loops at each end, and are sold by the 1,000, it is claimed that a great economy of time and labor is effected.

ROOT SPRING SCRAPERS

Spring scrapers manufactured by the Root Spring Scraper Company are patented machines that have been thoroughly tested and have seen severe service on all kinds of dirt roads. They are designed for rapid operation and will handle gravel at a speed of 10 to 15 miles per hour and snow at a speed of 35 miles per hour, doing better work the faster they go, and throwing the snow so far away as to prevent the formation of windrows.

The scraper has a 10-foot blade of high carbon spring steel, with a 2 x 1¼ inch oil tempered cutting edge which can be reversed, doubling its life. The scraper is mounted on heavy springs to resist the stress of high speed and is set at an angle of 45 degrees and operated by a double ratchet wheel and chain. When the scraper is out of commission the truck can be used for any other purpose. It is claimed that the scraper will cover six times the surface of any machine now in use for smoothing city streets.

The same company manufactures also a self-sharpening scarifier with long teeth projecting at both ends so that it can be used either side up and can also be hauled by attachment to any side or corner. It is hooked to the rear of a truck and loosens the road surface so that the gravel can be leveled into the holes.



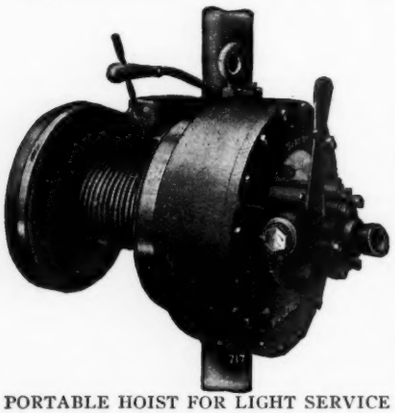
NASH QUAD, GOVERNMENT TYPE ROOT SPRING SCRAPER

ngineering JUN 4 1921

WAUGHOISTS

Waughoists, manufactured by the Denver Rock Drill Manufacturing Co., consist essentially of a small enclosed rotary engine geared to the shaft of the hoisting drum and forming a very light, compact and efficient portable hoist that can be attached to a girder, column, derrick mast, gantry, wall bracket or any other convenient support and is recommended for rapid light service and efficiency for all sorts of construction and industrial work where compressed air is available.

The principal parts of the hoist are the motor, the engine, motor housing, distributor, cylinder blocks, spider shaft and piston. The whole engine revolves in the motor housing where an air tight casing protects the engine and serves with an oil reservoir. As the engine is perfectly balanced there is no vibration and it can be instantly reversed by simply pushing the control lever to the opposite position. It has the splash



PORTABLE HOIST FOR LIGHT SERVICE

system automatic lubrication and is operated at high speed geared down 27.5 times for most efficient service. The horsepower is unusually great in proportion to the size and weight of the hoist. It has a brake horsepower of 5 at 100 pounds air pressure, and a capacity of 500 to 2,000 pounds hoisted vertically at the rate of 68 to 148 feet per minute. The drum has capacity for 1,000 feet of ¼-inch rope or 225 of ½-inch rope. It is supplied with 1½-inch air hose; its dimensions are 24½ x 19½ x 17½ inches, and its weight is 335 pounds.

LADDER TYPE STANDARD EXCAVATOR

This machine described in bulletin 4-X of the Pawling & Harnischefeger Co., is suited for heavier and deeper work than that of the wheel type machine and is recommended for depths to 20 feet. It has a well braced steel car body, mounted on caterpillar traction and equipped with a four cylinder vertical motor of the tractor type designed for continuous service and burning either gasoline, kerosene or distillate. The motor is gear connected to the machinery and is cooled by a water radiator. The main clutch is of the friction type and adjustable for heavy or light work or to overload or excessive shock. The double boom is of the box girder type with cast steel buckets having tool steel teeth. Corduroy tractors are driven by chains and easily dismantled for repairs. The belt conveyor is chain driven and delivers earth to either side of the machine. Its bearings exclude dirt and are lubricated by independent grease cups.

The standard depth of cuts are 8, 10, 12 and 22 feet. The width cut varies from 51 to 76 inches with the different machines. Six speeds are provided on all machines and vary from about ¼ to 3¼ feet per minute.

One of these machines averaged 500 feet per day of trench 9 feet deep and 27 inches wide. It made a record of 800 feet of this trench in one day, at a total cost of $7 for labor, $1.80 for fuel and 50 cents for lubrication.

INDUSTRIAL NOTES

The Post Tractor Company, of Cleveland, Ohio, and the Whitney Tractor Co., of Upper Sandusky, Ohio, have consolidated as the Post-Whitney Company, of Cleveland.

The Austin-Western Road Machinery Co., of Chicago, is now located at 400 North Michigan avenue.

The third annual convention of the National Lime Association will be held at Hotel Commodore, New York City, June 15, 16, 17. A number of technical, industrial and commercial papers will be presented, including one on "Problems to be considered in changing a quarry from hand method to steam shovel method," by Irving Warner, and one on "Wet mixed lime mortar," by W. C. Hay. A discussion will also be held on "Is the Central Mixing Plant the Next Step in Handling Lime and Concrete Mortars?" Exhibits will be made by the National Association and by the Eastern Bureau and there will be lunches and an evening banquet, with speeches, music and entertainment.

A 5-ton Federal truck in one day recently hauled a boiler to an elevation of 5,000 feet in the Sierra Nevada mountains under conditions that would have required a 28-mule team for three days. In some places there were 20 per cent up-grades and dangerous sharp turns and it was sometimes necessary on steep down grades to cut down and drag behind a good size tree for an additional brake.

The New Jersey State Highway Department announces the removal of its Northern Division Construction Office, Roy Mullins, Division Construction Engineer, from 790 Broad street, Newark, to 402 Broad street, Newark. The Bridge Division Office will remain at 790 Broad street.

H. M. Davison was from 1903 to 1919 with the Hayward Company, manufacturers of orange peel, clam-shell, electric motor clam-shell and drag scraper buckets, and for two years just past was general sales manager for the Ohio Locomotive Crane Co. He has again become associated with the Hayward Company and will hereafter be connected with the management of that company. Among other duties he will have the general management of sales.

PERSONALS

Sanborn, J. F., consulting civil engineer, announces the removal of his office to 50 Church street, New York City.

Sarr, Frederick, has been appointed first deputy highway commissioner, New York State Highwav Department, and Hotchkiss, H. G., has been appointed second deputy commissioner.

Kimball, S. Dexter, dean of the College of Engineering of Cornell University has been nominated president of the American Society of Mechanical Engineers.

Victor T. Goggin, recently New England sales manager of Fred T. Ley & Co., Inc., of Springfield, Boston and New York, has severed his connection with that concern to associate himself as contracting engineer with Dwight P. Robinson & Company, Incorporated, of New York, Chicago, Dallas, Youngstown, Los Angeles and Montreal.

Long, Bayard A., has been appointed sanitary engineer of Johnstown, Pa., to succeed H. J. Baum, who resigned.

Loewenstein, Jacob, for 18 years with the American Bridge Company, is now engaged as consulting engineer, specializing in the purchasing of steel for buildings, bridges and other structures. His offices are in the Equitable Trust building, New York City.

McKee, Wood, of Paterson, N. J., formerly state senator, has been reappointed to the North Jersey District Water Supply Commission by Governor Edwards, of New Jersey.

Daley, Patrick A., who for 39 years has been in the employ of the Water Division of Beverly, Mass., completed this service on April 18.

Herbert, H. D., has been elected borough manager of Carlisle, Pa.

Kaines, John, has been appointed superintendent of highways of the Onondaga Indian Reservation by the New York State Highway Department.

Wright, George C., for eleven years with the Monroe County, N. Y., engineer's office and since 1914 deputy county superintendent of highways, has been appointed county superintendent of highways of Monroe county, N. Y.

Crowley, William T., has been appointed city engineer of Lock Haven, Pa.

Anschutz, H. E., formerly with the Georgia Highway Department, has been appointed engineer of the city planning commission of Atlanta, Ga.

Hunt, E. G., has been appointed city engineer of Aberdeen, Wash.

Greene, Major-Gen. Francis V., police commissioner of New York in 1903 and from 1904 to 1915 president of the Niagara, Lockport & Ontario Power Co., died on May 15 in New York City.

TUNNEL ENGINEERS APPOINTED

The New Jersey Interstate Bridge and Tunnel Commission has appointed George W. Wells, St. John Clark and Col. George L. Watson engineers for the vehicular tunnel under the North river, from the Borough of Manhattan, New York, to Hoboken, N. J.